CTOBER 15, 1918 PRICE 25 CENTS

zine place a one-cent stamp on this notice, mail the magazine and it will be placed in the hands of our soldiers or sailors destined to proceed overseas. No wrapping—no address.

AVIATION AND AERONAUTICAL ENGINEERING

Spad Pursuit Airplane
French Official Photo

VOLUME V
Number 6

SPECIAL FEATURES

THE 300 HP. MAYBACH ENGINE
THE SOPWITH-CLERGET, "CAMEL"
AIRCRAFT BOLTS, SCREWS AND NUTS
SOME NEW ENEMY AIRPLANES
BRITISH ADVISORY COMMITTEE REPORT

Two Dollars a Year

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., INC.
120 WEST 32nd ST. NEW YORK

Entered as second-class matter, August 8, 1916, at the Post Office at New York, N. Y., under act of March 3, 1879

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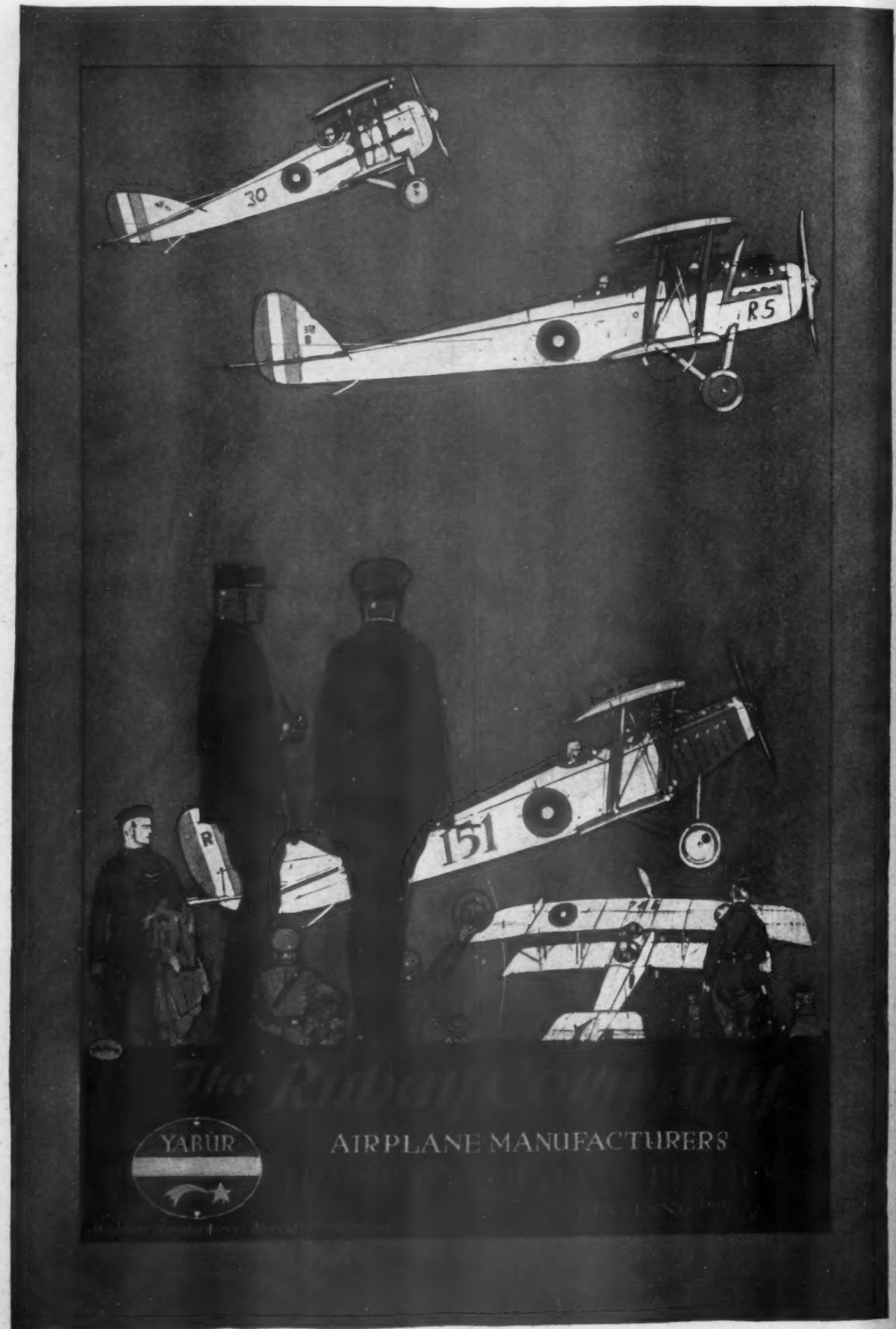
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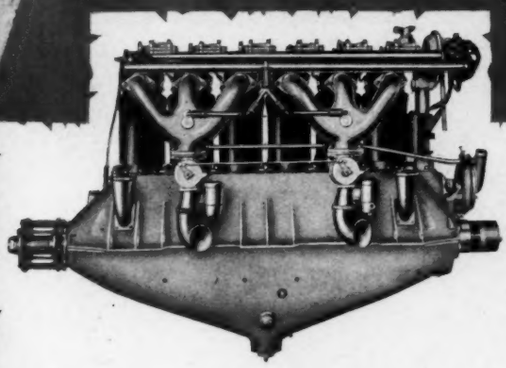


INTO the Hall-Scott Type L-6 Airplane Engine is concentrated the result of ten years' airplane building experience. This engine embodies the superior points of the well known type A-5 and A-5a models, and in addition the latest features in airplane engine practice.

Cylinders	Six
Bore	5 inches
Stroke	7 inches
Horse Power	200

Catalog on request

HALL-SCOTT MOTOR CAR CO.

Executive Offices--Crocker Building

San Francisco California

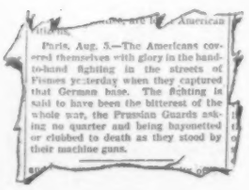
1908

HALL-SCOTT

Now—All Together!

NOTHING could stand against the mad dash of the French and American cavalry on the Marne—the German lines gave way, broke, fled; the day was won.

That fighting spirit of the men of Foch and Pershing, that united purpose—for Victory—*must be the spirit, the purpose, of each of us behind the lines.*



Paris, Aug. 5.—The Americans covered themselves with glory in the hand-to-hand fighting in the streets of Fismes yesterday when they captured that German base. The fighting is said to have been the bitterest of the whole war, the Prussian Guards asking no quarter and being bayonetted or clubbed to death as they stood by their machine guns.

We must lend as well as they fight. And we must pull together with all the strength we have—*now!*

We must so order our lives that we can save—to the limit—and lend—to the limit—for Victory. We must put America's whole strength behind our fighting men.

Now—All Together!

Let us lend the way they fight ***Let us buy bonds to our utmost***

L. W. F. ENGINEERING COMPANY, COLLEGE POINT, N. Y.

AIRCRAFT

MARTIN
U.S.A.

TRADE MARK

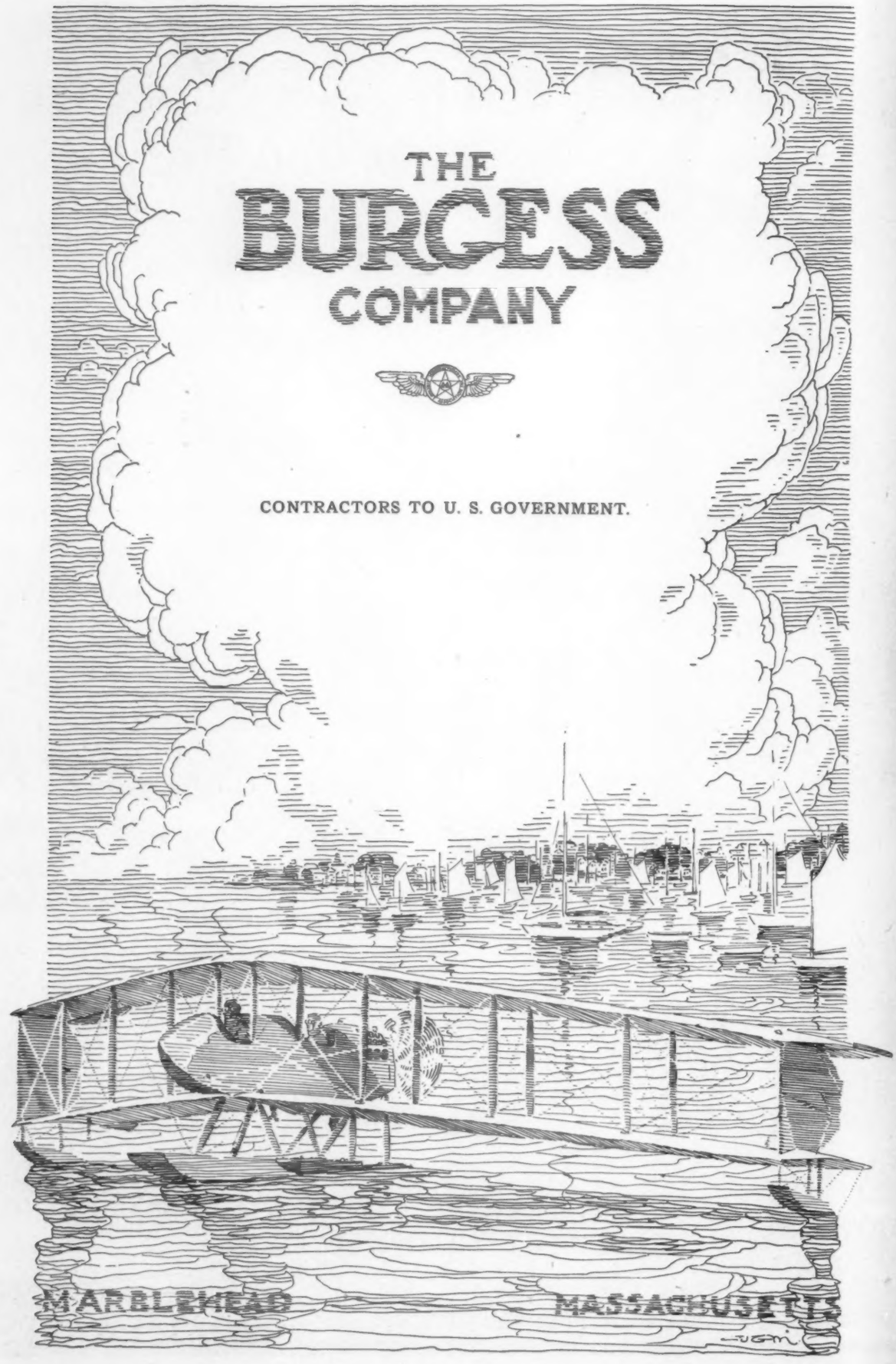
THE entire organization and skill, experience and ability of this company are devoted to intensive production in the interests of the United States for the period of the war.

WHEN peace comes Martin commercial and pleasure airplanes will maintain the supremacy of performance and dependability which they have held since 1909.

THE GLENN L. MARTIN COMPANY

CLEVELAND, OHIO

Contractors to the United States Government


THE
BURGESS
COMPANY
CONTRACTORS TO U. S. GOVERNMENT.
MARBLEHEAD
MASSACHUSETTS

The Air Supremacy of the Future

HOW much America will need aircraft after the war is fully realized by the Wright-Martin Aircraft Corporation.

Although the present activities of the plant are directed to war work and the production in quantities of the famous Hispano-Suiza engine, plans are already made for the industrial needs of the future.

This Company owns many basic aeroplane patents; it has among its executives some of the best-known figures in aeronautics; and its history since its foundation is a history of steady development and unusual success.

Wright-Martin Aircraft Corporation

New Brunswick, New Jersey
Long Island City, New York
- U. S. A.

TEAM-WORK

Today every American has his position to fill and his work to do—with his duty clear

By J. HORACE LYTLE

NO force on earth can defeat a sublime, popular patriotism—if backed by perfect Team-Work.

Team-Work is, and ever has been, the keynote of all success.

Let us illustrate in terms of the game. A team must play together—one man for the other—every play for the good of the team, as a whole, not the glory of any one player. This is true whether it be in football or business, baseball or WAR.

And such team-work wins games. Just as it also wins battles—and WARS.

The War is the greatest game we are playing today. It is the business of the hour. It is our business to win. WE ARE WINNING.

And it is the Team-Work, as well as the spirit, of America and her Allies that is doing it. America has a great team in the field. On this team are the soldiers, sailors, statesmen, workers, doctors, nurses, bankers, merchants, manufacturers—all working for the good of the whole.

On our team, in the trenches, we have poor boys, rich boys, farmer boys, colored boys—all fighting together side by side, advancing, falling, bleeding—dying side by side. It is the most perfect tribute the world has ever paid to the democratic principle. And it is the most superb Team-Work.

Those wonderful, those glorious boys in France are to our great war team what the back-field men are to a football team. They are carrying the ball. All praise to them—and let all the glory that can come be theirs!

But, let us in justice also remember, those lads in France could not go far if it were not for the part that others are playing behind the lines. Even though our work may not be so spectacular, let us do our duty. Doing our duty means—well, we all know what it means if we stop to think.

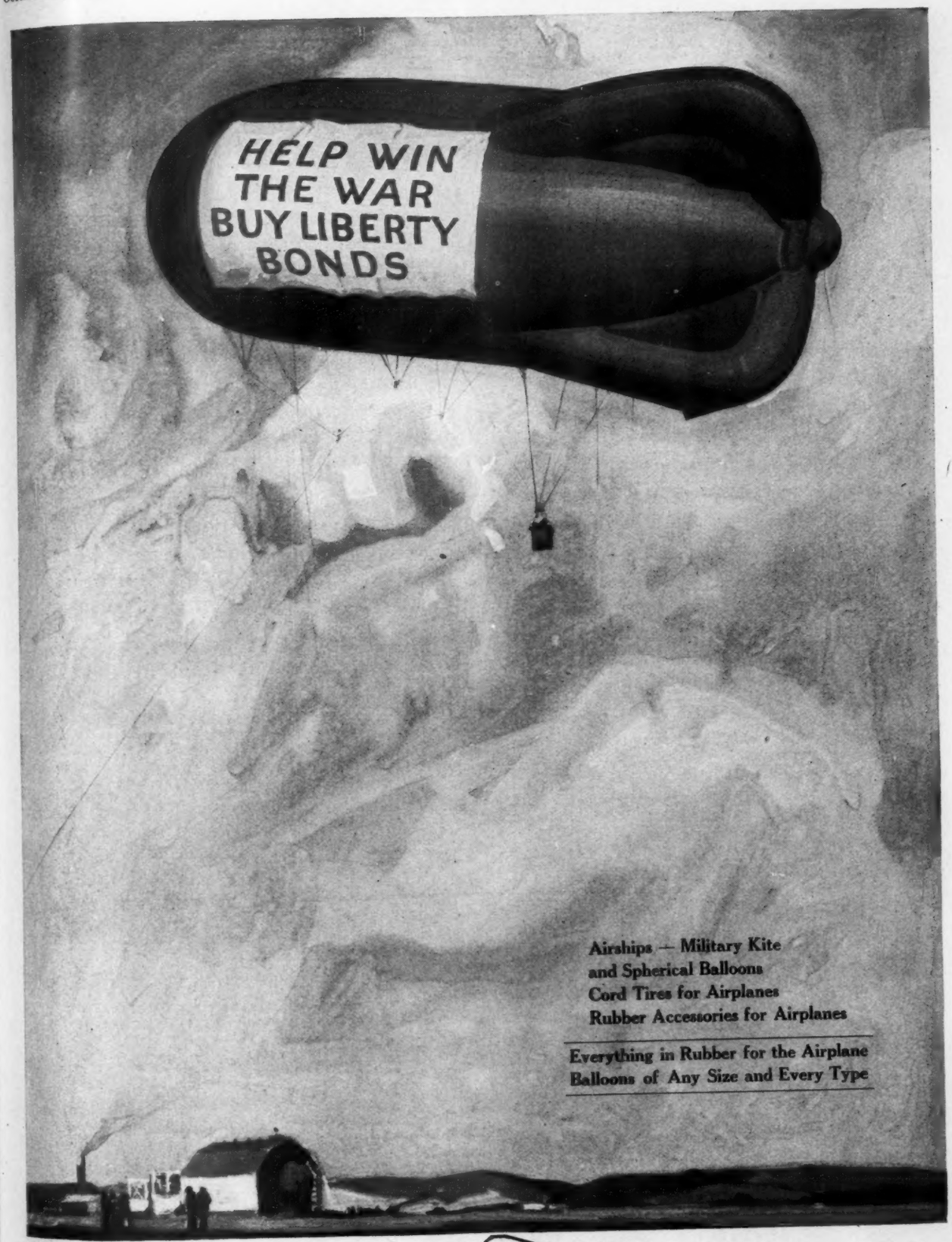
Right now it means *BUY BONDS* of the Fourth Liberty Loan.

Buy *MORE* Bonds! Before Oct. 19th!

And, by so doing, we will perfect the Team-Work behind the boys at the front with a strength that no force on earth can stop—and we will shorten the way for those lads in France on their march to Berlin.

This space contributed to the winning of the war by

THE DAYTON WRIGHT AIRPLANE COMPANY
DAYTON, OHIO *"The Birthplace of the Airplane"*



Airships — Military Kite
and Spherical Balloons
Cord Tires for Airplanes
Rubber Accessories for Airplanes

Everything in Rubber for the Airplane
Balloons of Any Size and Every Type

GOODYEAR
AKRON

92 *Lynite* Parts in Rolls-Royce Aviation Engine

The remarkable extent to which *Lynite* enters into the making of the airplane engine is shown by the record-breaking Rolls-Royce 12-cylinder engine now being produced in this country.

Ninety-two parts of this power-plant, which represents the work of some of the best engineering talent in Great Britain, are made of it.

These include such vital parts as crank-case castings and pistons, both of which require great strength.

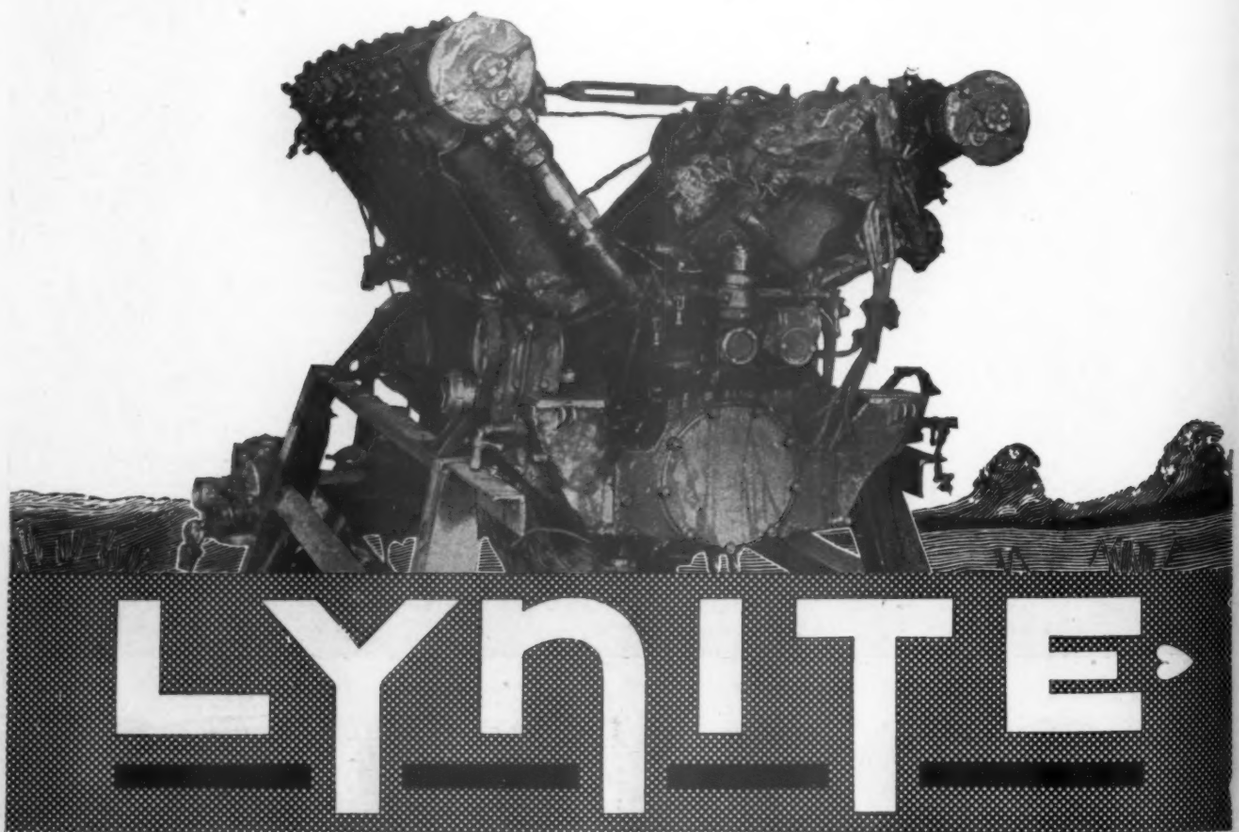
By the use of *Lynite* instead of cast-iron, Rolls-Royce engineers have saved 532 pounds without sacrifice of a single desirable quality, and, due to the exceptional heat-conductivity of *Lynite*, have obtained notable thermal efficiency.

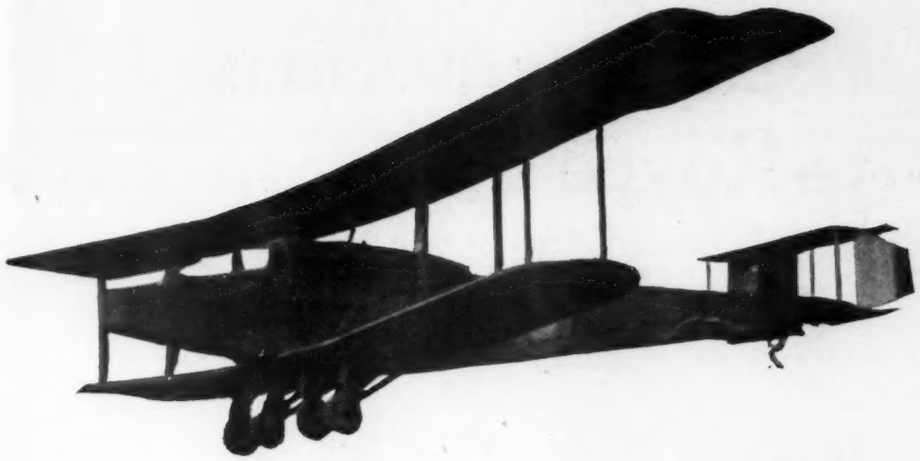
Airplanes fitted with Rolls-Royce engines hold world's records for speed, climbing, reliability, weight-carrying and passenger-carrying.

Rolls-Royce engines supplied the power for the history-making flight of a Handley-Page airplane from London to Constantinople. This exploit not only established a reliability record but hung up a new mark for weight-carrying. The total weight transported was six tons.

In making a world's record for passenger-carrying, Rolls-Royce power took 22 persons up 7,000 feet.

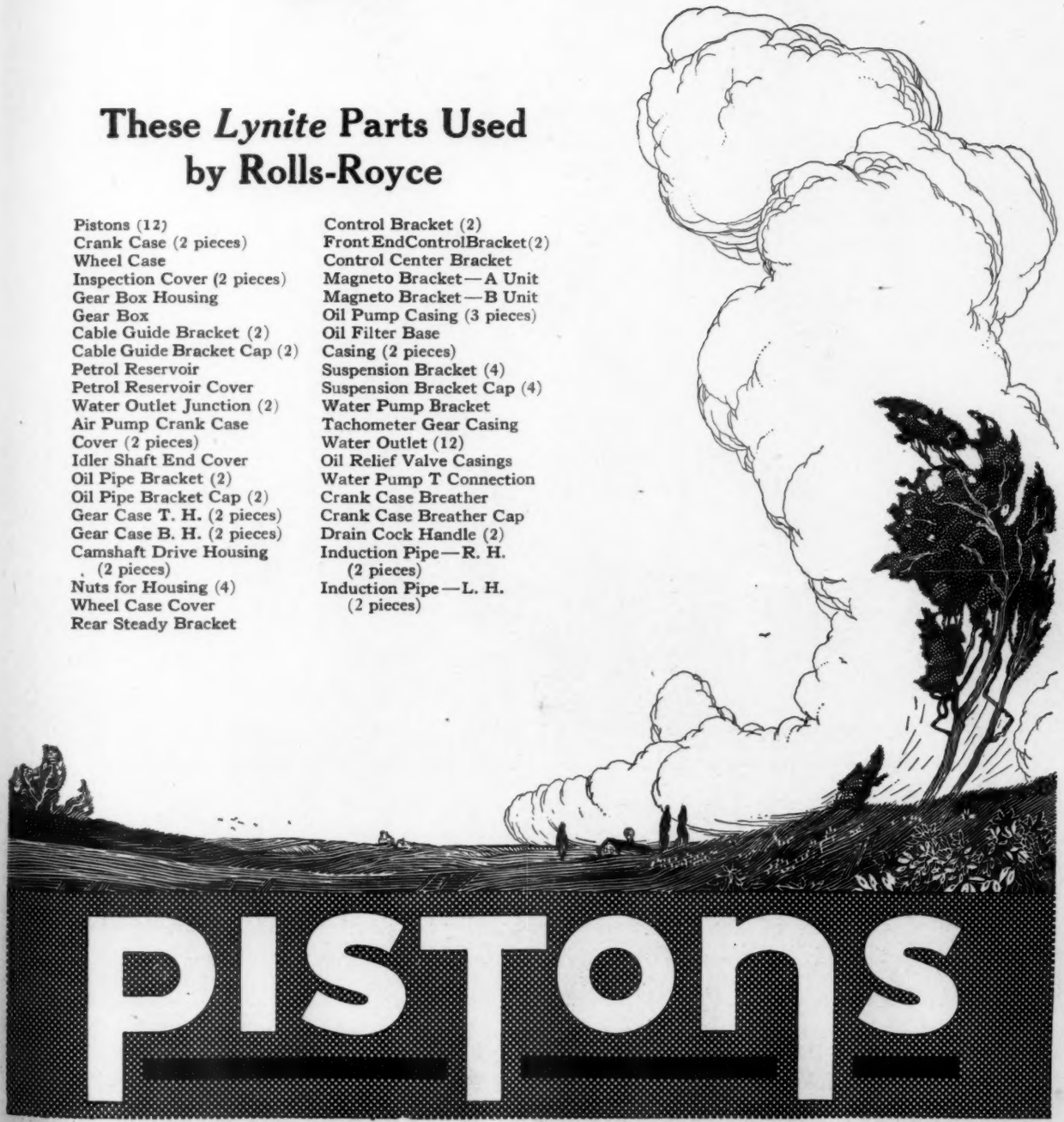
THE ALUMINUM CASTINGS COMPANY
LYNITE and LYNUX Castings
Eight Plants in
Cleveland Detroit Buffalo Manitowoc, Wis. Fairfield, Conn.





These *Lynite* Parts Used by Rolls-Royce

Pistons (12)
Crank Case (2 pieces)
Wheel Case
Inspection Cover (2 pieces)
Gear Box Housing
Gear Box
Cable Guide Bracket (2)
Cable Guide Bracket Cap (2)
Petrol Reservoir
Petrol Reservoir Cover
Water Outlet Junction (2)
Air Pump Crank Case Cover (2 pieces)
Idler Shaft End Cover
Oil Pipe Bracket (2)
Oil Pipe Bracket Cap (2)
Gear Case T. H. (2 pieces)
Gear Case B. H. (2 pieces)
Camshaft Drive Housing (2 pieces)
Nuts for Housing (4)
Wheel Case Cover
Rear Steady Bracket
Control Bracket (2)
Front End Control Bracket (2)
Control Center Bracket
Magneto Bracket—A Unit
Magneto Bracket—B Unit
Oil Pump Casing (3 pieces)
Oil Filter Base
Casing (2 pieces)
Suspension Bracket (4)
Suspension Bracket Cap (4)
Water Pump Bracket
Tachometer Gear Casing
Water Outlet (12)
Oil Relief Valve Casings
Water Pump T Connection
Crank Case Breather
Crank Case Breather Cap
Drain Cock Handle (2)
Induction Pipe—R. H. (2 pieces)
Induction Pipe—L. H. (2 pieces)



PISTONS

STRAIGHT FROM THE TRENCHES

If you want to keep us feeling this way-

Fourth Liberty Loan

One of a series of advertisements specially originated and produced for the Liberty Loan Committee entirely by members of the American Expeditionary Force

UNION GAS ENGINE CO.
OAKLAND, CAL.

Protecting *the* Air Fleet 34 Ways

Success in fight or flight may depend directly on the varnish used. When wings are punctured the " dope " and Varnish must hold fabric against stretch or spread.

Airplanes to win must endure all extremes of temperature and climate.

When a varnish is put on an airplane it must be able to endure the noonday's sun in the Mesopotamian Desert and Arctic nights on the Murman coast equally well and without the slightest impairment.

The U. S. Varnish requirements for airplanes are so exacting that only the best varnish can expect to meet them. Thirty-four tests must be met. These requirements include every test to which a varnish may be put in war, home or industry.

Air-Plane Rexpar Varnish has met these thirty-four tests and received a first order for 50,000 gallons.

Every gallon of Air-Plane Rexpar Varnish is equal in quality to every other gallon.

Air-Plane Rexpar will merit your approval just as at merited the approval of the United States Government.

We can make immediate delivery of Air-Plane Rexpar Varnish in any possible quantity that you may require.

The Sherwin-Williams Company

801 Canal Road, Cleveland, Ohio

Branch Offices and Warehouses in all Important Cities

The varnish on airplanes shall

1. Protect wood.
2. Protect doped linen.
3. Protect doped cotton.
4. Protect metal.
5. Be long oil varnish.
6. Resist air.
7. Resist light.
8. Resist water.
9. Resist natural gas.
10. Resist illuminating gas.
11. Have proper brushing qualities.
12. Have proper flowing qualities.
13. Have proper covering qualities.
14. Have suitable body.
15. Dry dust free rapidly.
16. Harden rapidly.
17. Be elastic.
18. Be clear.
19. Be transparent.
20. Be highest quality.
21. Match a fixed color solution.
22. Be durable.
23. Not flash below 95 degrees Fahr.
24. Not whiten under water.
25. Not dull under water.
26. Not show defects under water.
27. Stand air test during application.
28. Stand air test during drying.
29. Meet a fixed setting test.
30. Meet a threefold drying test.
31. Meet a severe bending test.
32. Be inspected before shipment.
33. Be inspected at destination.
34. Prove durable under fixed test.

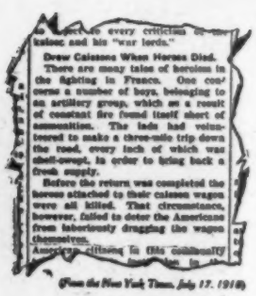
Sherwin-Williams Air-Plane Rexpar meets all these requirements

BAKER CASTOR OIL COMPANY
120 Broadway New York City

Radiation not just Radiators
The cellular type of radiators has been adopted by the U. S. Government as the standard type for aeroplane work.
The MAYO Radiator is best suited for aeroplane use because of its light weight and because, by reason of its greater efficiency, it requires less frontal area.

MAYO Radiators

MAYO RADIATOR DIVISION of MARLIN ROCKWELL Corporation · 143rd Street and Southern Boulevard, NEW YORK CITY



every criticism of ... kaiser and his "war lords."

Drew Caissons When Horses Died.

There are many tales of heroism in the fighting in France. One concerns a number of boys, belonging to an artillery group, which as a result of constant fire found itself short of ammunition. The lads had volunteered to make a three-mile trip down the road, every inch of which was shell-swept, in order to bring back a fresh supply.

Before the return was completed the horses attached to their caisson wagon were all killed. That circumstance, however, failed to deter the Americans from laboriously dragging the wagon themselves.

American citizens in this neighborhood ...

(From the New York Times, July 17, 1918)

THEY GOT THERE IN TIME

They are in the fight with every muscle every faculty of their minds, every drop of their American blood

You have read in the daily news the story of what one detachment of American artillerymen did on the Marne when their ammunition was running low.

Every shell in that caisson meant a speedier winning of the war—all the horses were killed—*but the shells got there just the same. And they got there in time.*

Where shall *we* draw the limit when we read what *they* are doing over there? *Now* is the time to put our full strength into it. Our strength, coupled with the power of our Allies, will win. Let us not delay even a few months. Let us get there *in time to hasten the victory—to save the lives of our sons.*

How can any one of us, back here at home, set *any* limit to the help we ought to give—for *victory?* And we must get it there *in time!*

We Must Lend the Way They Fight— We Must Buy Bonds to Our Very Utmost!

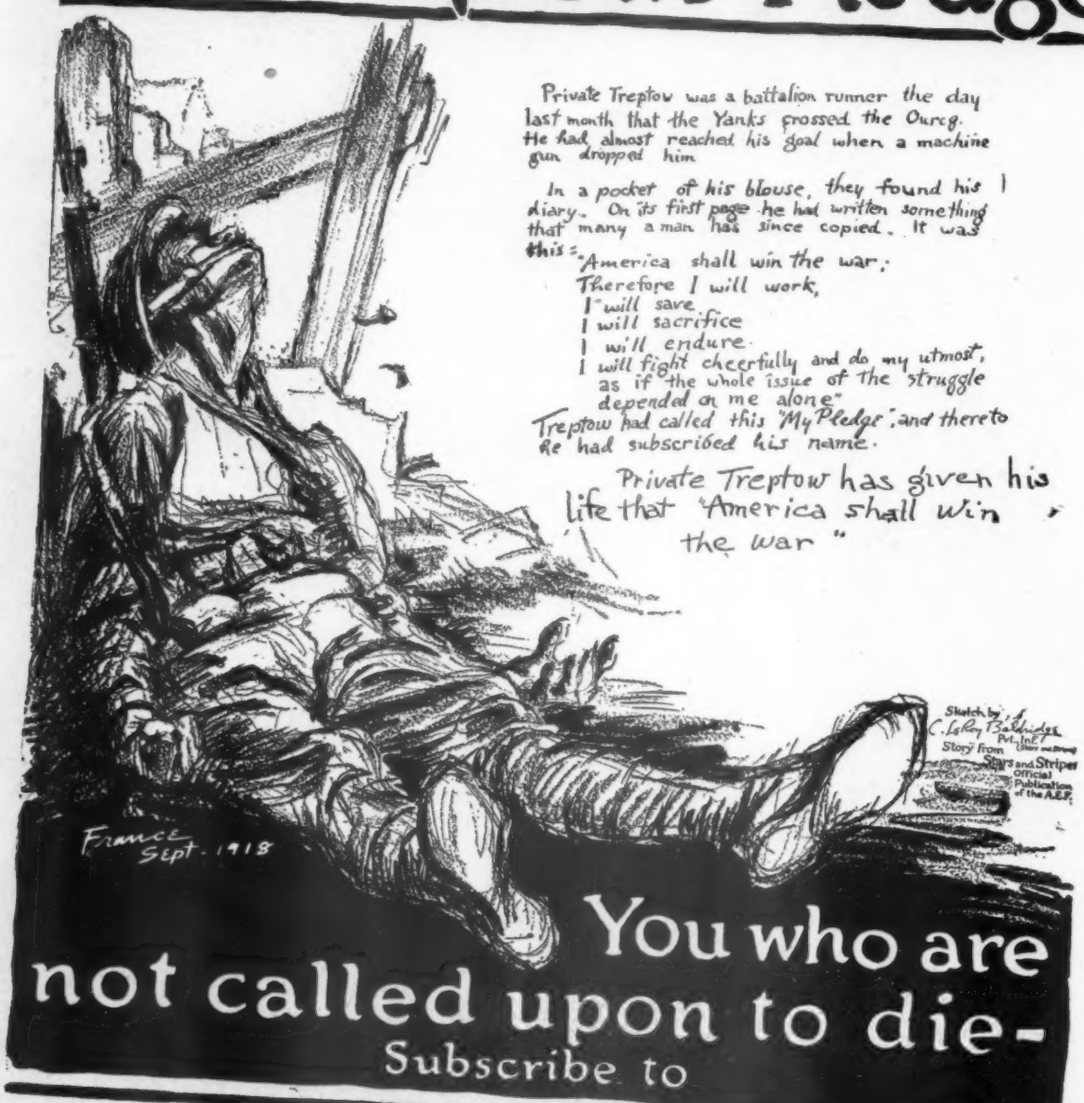
This Space Contributed to Winning the War by

THOMAS-MORSE AIRCRAFT CORPORATION, ITHACA, N. Y.

BETHLEHEM
The Supremacy of
FEDDERS
RADIATORS
FEDDERS MFG. CO. Inc.
BUFFALO, N.Y.

STRAIGHT FROM THE TRENCHES

Pvt. Treptow's Pledge


Private Treptow was a battalion runner the day last month that the Yanks crossed the Ourcq. He had almost reached his goal when a machine gun dropped him.
In a pocket of his blouse, they found his diary. On its first page he had written something that many a man has since copied. It was this:
"America shall win the war.
Therefore I will work,
I will save.
I will sacrifice
I will endure.
I will fight cheerfully and do my utmost, as if the whole issue of the struggle depended on me alone."
Treptow had called this "My Pledge" and thereto he had subscribed his name.
Private Treptow has given his life that "America shall win the war"
Sketch by C. LeRoy Baldridge, Pvt. Inf. U.S.A. Story from Stars and Stripes Official Publication of the A.E.F.
France Sept. 1918

You who are not called upon to die-
Subscribe to

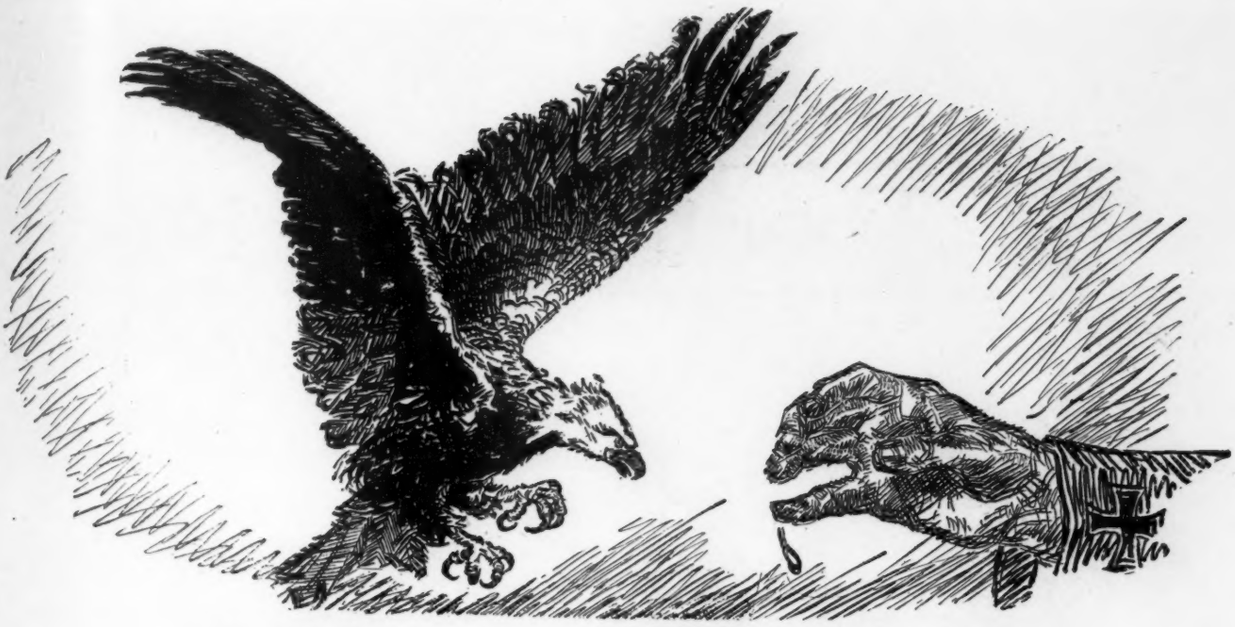
the Fourth Liberty Loan

Contributed to the Winning of the War by

RADIUM DIAL COMPANY

GENERAL OFFICES—PITTSBURGH, PA.

501 FIFTH AVE., NEW YORK—MARSHALL-FIELD ANNEX BLDG., CHICAGO—LITTLE BLDG., BOSTON
DIAL PAINTING FACTORIES, PITTSBURGH, LONG ISLAND CITY, N. Y., CHICAGO



Whose Fight?

THREE MILLION MEN—half of them in France—many more in training.

But is this all their fight?

It takes ten men at work to keep one fighting man at the front.

It takes millions of dollars just to keep this army fed. It costs thousands of dollars every time one battery of big guns lays down a barrage.

Is it any wonder then, that the United States is spending at the rate of *fifty millions of dollars a day* in war and war plans? And with that grand total as the interest on a far vaster principal, which must support this colossal cost or all this task will have been in vain, whose fight do you think this is?

The man's in the trench? The fellow's on the supply-train? The chap's on the gunner's deck?

No, it is yours!

It is *your* fight, Mr. Banker—*yours*, Mr. Manufacturer—*yours*, Mr. Merchant—*yours*, Mr. Mechanic—*yours*, Mr. Worker—*yours*, Mr. Farmer. This fight is yours, all of you who are left behind, as much or even more than it is the man's in the trench.

For that man, though three million strong, cannot raise a hand in the cause of democracy, he cannot even raise a hand in self-defense, except *for you*.

He is potent only as you are potent. He can fight only as you *will* fight. The difference is only this: *his* fight is expressed in nerve and ammunition, *yours* in work and dollars.

The Fourth Liberty Loan is the world's biggest drive back of the lines. It is the test of the financial reserves of this entire country of ours. It will gauge the power that you intend to put back of the fighting men in France for the next half year or more to come.

In fact it will show the value *you* place on the heritage of liberty, which three million men have taken up arms to defend *for you* to-day.

Take care when you sign that subscription blank for Liberty Bonds that the amount you set squares as nearly as it can with all your heart acknowledges this heritage to be worth to you.

Buy United States Government Bonds
OF THE FOURTH LIBERTY LOAN

This Space Contributed to Winning the War by

B. F. STURTEVANT COMPANY
STURTEVANT AEROPLANE COMPANY
BOSTON, MASSACHUSETTS

Dollars that Fight

By SENATOR HENRY CABOT LODGE

The war will be won by men and ships, by guns and airplanes. To raise armies and supply them, to build the navy and support it, and to furnish ships and transport, we must have money in large amounts. The expenditures of the Government for the ensuing year are estimated at $24,000,000,000, a sum which baffles the imagination to conceive. That vast amount must come one-third from taxes and two-thirds from loans. The success of the Fourth Loan, like those that preceded it is, therefore, absolutely necessary. We must work with the highest speed, as if the war was to end in six months. We must prepare in every direction, as if it was to last for years. Speed and preparation are both expensive.

Without the Loans We Cannot Have Either

We are fighting to secure a just, righteous and lasting peace. For a complete peace we must have a complete victory. It must not be a peace of bargain or negotiation. No peace which satisfies Germany can ever satisfy us. No peace that leaves Germany in a position to renew the war against us will be worth having. It will be far from sufficient to gain all our objects on the Western front—Belgium, Alsace-Lorraine, Italia Irredenta. The President with wisdom and foresight and great force expressed his determination to redeem Russia. Russia must not be left in Germany's hands. That would mean another war. Poland must be free. Slav republics must be established to bar the way between Germany and the East. Serbia and Roumania must be redeemed. All these things are essential. *Nothing will bring them but complete victory and a peace dictated by us and our allies.* It is a conflict of ideas. It is the principle of evil arrayed against the principle of good. It is the battle of freedom and civilization against barbarism and tyranny. *We must win and we shall win.*

We Cannot Win Without Money, and, Therefore, These Loans Are Vital, and the Country Should Rally in All Its Strength and Subscribe and Oversubscribe the Fourth Loan

Buy Bonds to Your Utmost!

This Space Contributed to Winning the War by

SPERRY GYROSCOPE COMPANY, BROOKLYN, NEW YORK

To Speed up Repairs

Here's something absolutely new—and as practical, efficient and time-saving as it is original.

The Beach Automatic Grip Puller (Junior Size) is designed to remove all gears—on *all* aeroplane motors—quickly and easily. It is the *only* automatic grip puller on the market and is ideally adapted for shortening overhauling and repair-work time.

By simply turning the hardened tool steel screw at the top, the drop forged jaws automatically grip work and *hold*. Removal of the timing, magneto and pump shaft gears and couplings is then only a matter of seconds.

And it's light, too, weighing but 3¼ lbs. with the extra set of arms furnished with each tool.

Remember the BEACH AUTOMATIC GRIP PULLER (Junior Size) is adapted to any type of aeroplane motor, by simply changing the arms to fit the gears which are to be pulled.

The BEACH is the ideal repair-shop and factory tool—thousands are in use now all over the country. Just the puller for the tool kit. It does away with the necessity of building a special puller for each set of gears.

It is a combination of two or three jaws.

Write for our illustrated leaflet which gives full details of this great little time saver.

We also manufacture a large size BEACH AUTOMATIC GRIP PULLER—capacity 1″ to 18″—for heavy duty work.

CONTRACTORS TO THE UNITED STATES GOVERNMENT

The Greb Company

MANUFACTURERS OF AUTOMOTIVE AND GARAGE EQUIPMENT

190 State Street, - - Boston

"ACES" UP!

We are proud of the part that Dural products are playing in helping the American aces to win success in the air.

Rubber Parts for Aircraft

are our specialty. We were among the first in the field and as a result of our experience and knowledge, we have built up a quantity production with all its advantages of quick deliveries—yet every part is

MADE AND INSPECTED AS IF IT WERE THE ONLY ONE

Our chemical laboratory and staff of experts are at your disposal to work out new ideas.

It is possible that in our experimental work we have covered the very ground you are traveling towards something new and better in rubber parts for aircraft. It will save you much time and money if you allow us to show you the trail we have blazed, marked and logged.

Write to

DURAL RUBBER CORPORATION
FLEMINGTON NEW JERSEY

"DURAL-Above All"

"SERVICE"

"NORMA" PRECISION BALL BEARINGS

(PATENTED)

Preeminence must rest on performance. Claims are futile things, in these times when service is sought from all and placed before all. And nothing but the staunchest serviceability can maintain that character of performance which stands for full service faithfully rendered.

"NORMA" Precision Bearings—the standard bearings in high-grade ignition and radio electric apparatus—have to their credit years of performance records under such speed conditions as to establish their preeminence beyond question.

BE SURE—See that your Electrical Apparatus is "NORMA" Equipped

THE NORMA COMPANY OF AMERIC
1790 BROADWAY NEW YORK

Ball, Roller, Thrust and Combination Bearings.

"NORMA"
PATENTED

OCTOBER 15, 1918

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. V. NO. 6

Member of the Audit Bureau of Circulations

INDEX TO CONTENTS

	PAGE
The 300 H.P. Maybach Engine	357
The Sopwith-Clerget "Camel"	361
Aeronautical Patents	362
Production Problems of Aircraft Bolts, Screws and Nuts	363
Some Enemy Airplanes	365
British Advisory Committee Report for 1917-18	368
New Duesenberg Engine Test House	371
Digest of the Foreign Aeronautical Press	372
News of the Fortnight	373

THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*
120 WEST 32D STREET, NEW YORK
WASHINGTON OFFICE, EVENING STAR BUILDING

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES TWENTY-FIVE CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR. COPYRIGHT. 1918, BY THE GARDNER-MOFFAT COMPANY, INC.

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A Soldier Facing Death For You

Somewhere in France today, at this very minute, there is a soldier looking straight into the face of death.

He is doing this for *you*.

By night and day, in storm, in rain, in cold and gloom, facing a hundred deaths he never hesitates a minute but does his duty without a thought of hesitation and without a thought of reward.

What are you doing for him today?

When you think of that man don't you want to do something to prove that you appreciate what he is doing for you?

Of course you do. Then act on your desire and buy *Liberty Bonds* which will help to safeguard him and to bring him back home.

After *you* have bought all you can tell your friends to do the same.

BUY LIBERTY BONDS TODAY
ANY BANK WILL HELP YOU

THIS SPACE CONTRIBUTED TO WINNING THE WAR BY
WYMAN-GORDON COMPANY, WORCESTER, MASS.

Quality

Mill Annealing

Taking Samples for Chemical Analysis

Inspecting Raw Stock for size and Surface Defects

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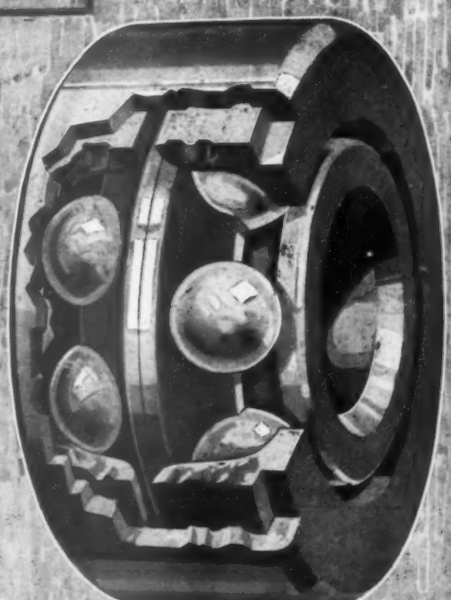

New Departure Ball Bearings

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Vol. V | October 15, 1918 | No. 6

The 300 Horsepower Maybach Engine*

During the past few months several of the latest type of Rumpler C. machines have been captured fitted with the new 300 hp. Maybach engines. The general layout of this engine follows the usual German vertical, six-cylinder type. The compression ratio is exceptionally high, viz., 5.94:1, which necessitates the use of very heavy pistons and connecting rods; in these particulars this engine follows the previous Maybach practice, but the adoption of a cast-iron floating bush in the little end bearing is an interesting development.

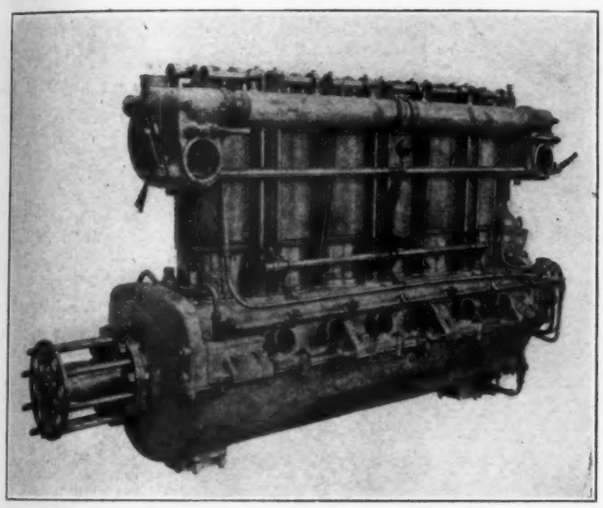


FIG. 1. INDUCTION SIDE OF ENGINE

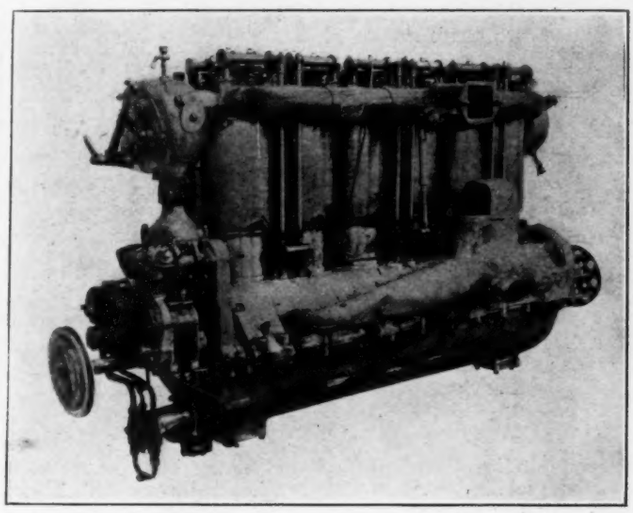


FIG. 2. EXHAUST SIDE OF ENGINE

Four overhead valves per cylinder are fitted—i. e., two inlet and two exhaust. These are operated by rocker levers mounted on roller bearings in brackets fixed to the cylinder heads and by push rods on each side of the cylinders actuated by separate inlet and exhaust camshafts.

The camshafts run in plain bronze bearings in the crank-chamber and are splash lubricated.

The three separate and detachable gear oil pumps, which are situated in the bottom of the base chamber, are of new design.

The pump driving shaft at the front end is driven through a ratchet gear on the front scavenger pump, apparently with the object of preventing an air lock in the lubrication system in the event of backfiring.

A double-acting, oil-sealed gasoline pump of unusual design is now fitted. This is driven off an extension of the main oil pump spindle at the rear end of the base chamber, and works, of course, in conjunction with the two separate carbureters. These are of the well-known Maybach type, and have been only slightly modified; as shown in Figs. 1 and 2 they are attached, as in the Zeppelin engines, to the front and rear cylinder water jackets.

The well-known Maybach induction type starting gear is fitted, but is slightly modified in design.

The whole of the induction system and the oil condensing crankcase ventilating system is an interesting point in the design of this engine, as is also the method of attaching the propeller-hub driving flange on the tapered front end of the crankshaft.

Ignition is by two Bosch high tension magnetos, which are driven off the rear ends of the camshafts.

Cylinders—In comparison with the Zeppelin-Maybach engines, the cylinder of the new 300 hp. Maybach engines are of very much lighter construction; and, as will be seen from Fig. 3, are of a wonderfully clean design.

FIG. 3. A CYLINDER, COMPLETE

Each cylinder is built up of a thin barrel, machined and ground to 165 mm. bore, and machined on its outer surface to a thickness of 3 mm. The thickness is increased from 3 mm. at the bottom of the water jacket to 4.5 mm. at the cylinder base flange. Into the top of the cylinder barrel is screwed the cylinder head, which is of cast-iron. A detailed sketch of this screwed joint is shown in Fig. 4. The screw thread is 2.3 mm. pitch, buttress thread. A soft brass washer is fitted at this joint between the cylinder head and the top face of the screwed portion of the cylinder barrel.

The bottom of the cylinder barrel extends only 3.5 mm. below the base flange into the registering joint of the crankcase, and the bore of the cylinder is very little chamfered.

* Excerpt from a report issued by the Technical Department of the British Air Ministry.

The design of the cylinder heads and the formation of the water passages round the twin inlet and exhaust valves is unusual, and the double inlet and outlet water connections between each pair of cylinders are of new design. The formation of these twin water connections is shown in Fig. 5, together with the water passages cast round the sparking plug bosses; the latter are somewhat inaccessibly situated in the space between the two cylinder head water joints. The two semi-circular bosses which are cast on the sides of the cylinder water joints are provided for the attachment of the two carbureters, which are fixed to the front and rear cylinders by long studs

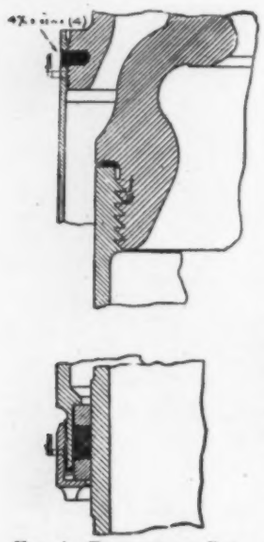


FIG. 4. DETAILS OF CYLINDER HEAD AND WATER JACKET SCREWED JOINTS

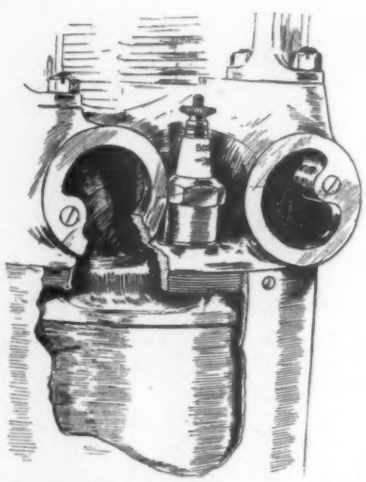


FIG. 5. SKETCH OF CYLINDER HEAD, SHOWING WATER PASSAGES AND CONNECTIONS

screwed into these bosses in the water joints. To allow for the interchangeability of the cylinders these holes are drilled in every cylinder; when the cylinder is not assembled at the front or rear they are plugged with brass grub screws, as shown in the sketch.

An interesting point of design in these cylinders lies in the fact that no water connections between the cylinders are made other than the twin head-joints referred to.

The exhaust valve pockets are provided with an additional water passage above the exhaust port, and cast so as to give a free water space completely round the center portion of each exhaust valve-stem guide (Fig. 6).

The valve guides cast in the cylinder heads are fitted with cast-iron bushes pressed into position. The exhaust bushes do not extend the full length of the guides as the inlet do, but are kept back a distance of 10 mm. from the bottom of the guide, so that they are protected from the hot gases. As a further precaution against seizing, the diameter of the bottom of the exhaust bush is slightly reduced, so that the bush has room to expand.

Contrary to the usual German practice of building up the water jackets of sheet steel acetylene-welded at the joints, the water jackets are machined from cylindrical steel forgings, which, as shown in Fig. 4, are screwed on to the flange machined on the cylinder head; the pitch of this thread is 1 mm. This screwed joint is finally sweated in position with soft solder, the whole depth of the screwed portion having apparently been previously tinned; the joint is locked with four 6 mm. grub screws.

The whole of the water jacket is machined both on the inside and also on the outside surface to a thickness of 1 mm. The water jackets extend to 104 mm. from the base of the cylinder, or, roughly, to two-thirds of the total length of the cylinder barrels; but, as will be noted, the water space is exceptionally narrow—i. e., 7 mm.

The only water passages from the cylinder head to the annular water space of the water jackets is through the openings or passages cast in the cylinder heads encircling the sparking plug bosses. and situated directly below the twin water connections. The formation of these water passages leading from the head of the jacket is made clear in the perspective sketch (Fig. 5).

The water jacket capacity of one cylinder = 1284 C.C.S.

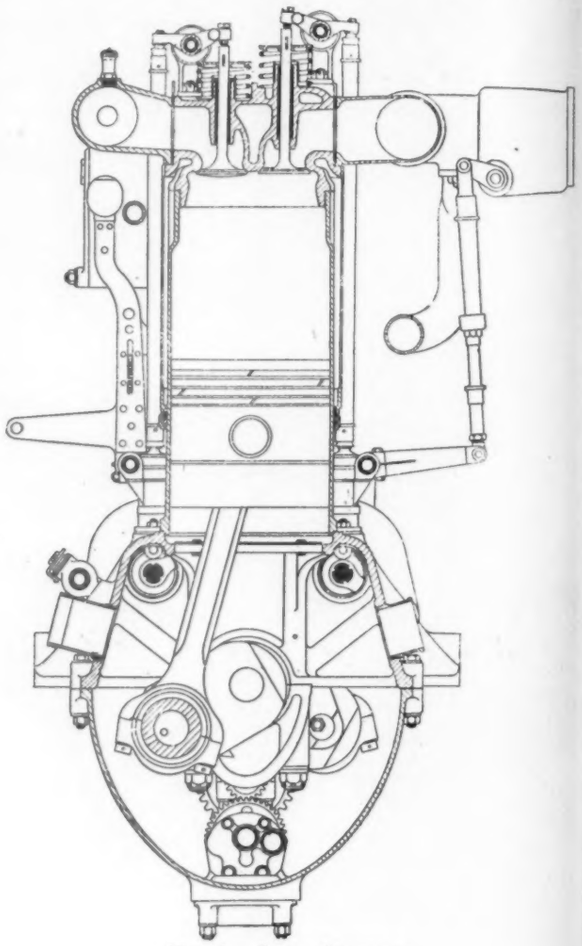


FIG. 6. CROSS SECTION

Fig. 4 shows an enlarged view of the lower joint between the cylinder barrel and the water jacket. This joint consists of a soft rubber composition packing ring, compressed in position between two steel rings by a large ring which screws on to the bottom of the water jacket by a fine pitch thread in the manner shown in the sketch. This joint is, to a certain extent, flexible, and allows for the relative expansion between the cylinder barrel and the water jacket.

Small drain plugs are provided at the bottom of each cylinder water jacket; these are screwed into bosses welded into the water jackets on the exhaust side. The combustion chamber is circular, but it is slightly recessed below all of the four valve seats, which are all of the same diameter—i. e., 54 mm.

The area of both the inlet and exhaust ports is 30.15 sq. cm. =4.66 sq. in.

The clearance volume of one cylinder=778.9 cu. m.=47.54 cu. in., giving a compression ratio of 5.94: 1.

Short pieces of aluminum tube are fitted over the top ends of the lugs in the cylinder heads forming the valve stem guides. These are apparently provided for lubrication purposes. Thin sheet steel plates are bolted to the inlet and exhaust ports of the cylinder heads to stiffen up the engine.

Pistons—The pistons are of cast-iron, and weigh 12.3 lb. each, complete with rings. Four rings are fitted all above the gudgeon pin, the lower one being a scraper ring. All the rings are concentric, and are 6.5 mm. wide (vertically) and 5.5 mm. deep, the depth of the ring grooves being 6 mm.

The pistons, as will be seen in Fig. 7, are flat on both the top and bottom surfaces of the crown, which is 10.5 mm. in

thickness. Eight 4 mm. return oil holes are drilled through the piston below the scraper ring in the usual way.

The rings are cut diagonally at 45 deg., no locating pegs being fitted; and the width of the ring gap in the cylinder is 1.39 mm.=.055 in.

All the piston rings are machine hammered on their inner surfaces. This process, which is now extensively used, and is well known, consists of subjecting the inside face of the ring to a series of mechanical hammer blows at gradually increasing

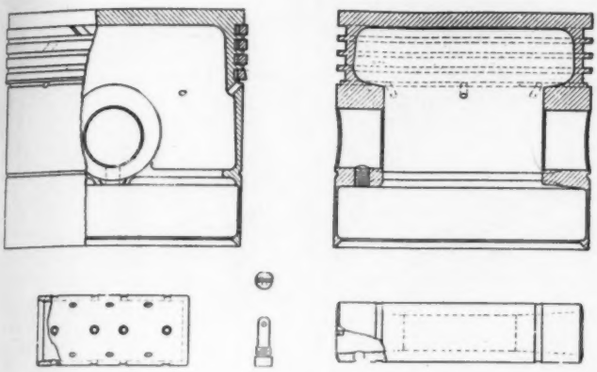


FIG. 7. DETAILS OF PISTONS, GUDGEON PINS AND FLOATING SMALL-END BUSHES

distances apart. The process shows a large number of small transverse depressions extending nearly the width of the ring on the inner surface. These depressions caused by the hammer are approximately 1 mm. apart at the back portion of the ring—i.e., the part of the ring farthest from the gap—and increase in mathematical progression to about 4 mm. apart towards the front of the ring up to about one inch, on either side of the gap. This mechanical hammering of the inside ring has the effect of giving the desired uniform pressure to the concentric ring against the cylinder wall.

The holes for the gudgeon pin are bored eccentrically in the

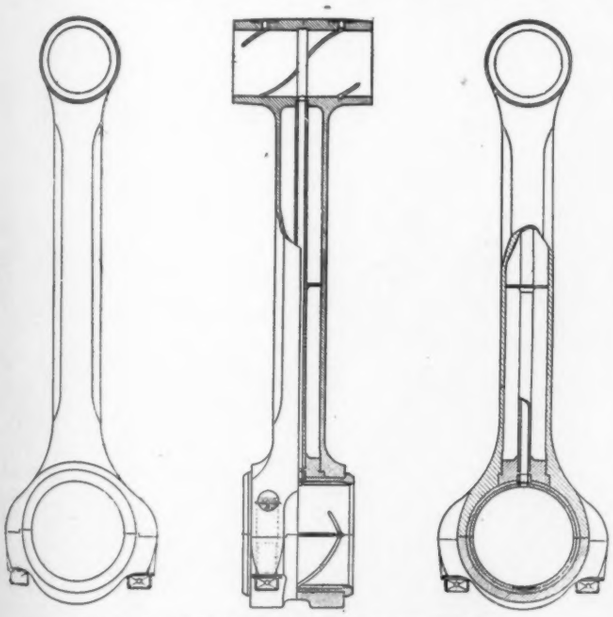


FIG. 8. DETAILS OF CONNECTING RODS

gudgeon pin bosses, giving a thickness of metal of 14 mm. above and 9 mm. below the gudgeon pin. An oil groove is cut in the piston skirt below the gudgeon pin, evidently to assist the scraper ring and the piston lubrication. The inside of the skirt is machined up as far as the bottom of the gudgeon pin bosses, and a beveled lip is turned on the bottom flange of the skirt. The inside of the piston is also machined flat across the head, and down as far as the top of the gudgeon pin bosses with a 15 mm. radius; an annular rib is cast on the inside of the skirt to reinforce the gudgeon bosses.

Gudgeon Pins—The gudgeon pins are 159 mm. long, slightly beveled at the end, and are fixed in position in the piston by a single cheese-headed 9 mm. set screw in the usual way and locked with a split pin.

The gudgeon pins are hardened and ground to three parallel outer diameters, being made of smaller diameter at one end than the other. The center portion which makes the small end bearing is 38 mm. diameter, and the two ends which fit into the gudgeon pin bosses are 37.5 and 38.25 mm. diameter respectively.

The gudgeon pins are bored 23 mm. diameter in the center tapering to 28 mm. at each end.

Floating small end bushes are now fitted to the gudgeon pin in the connecting rod smaller ends. These floating bushes

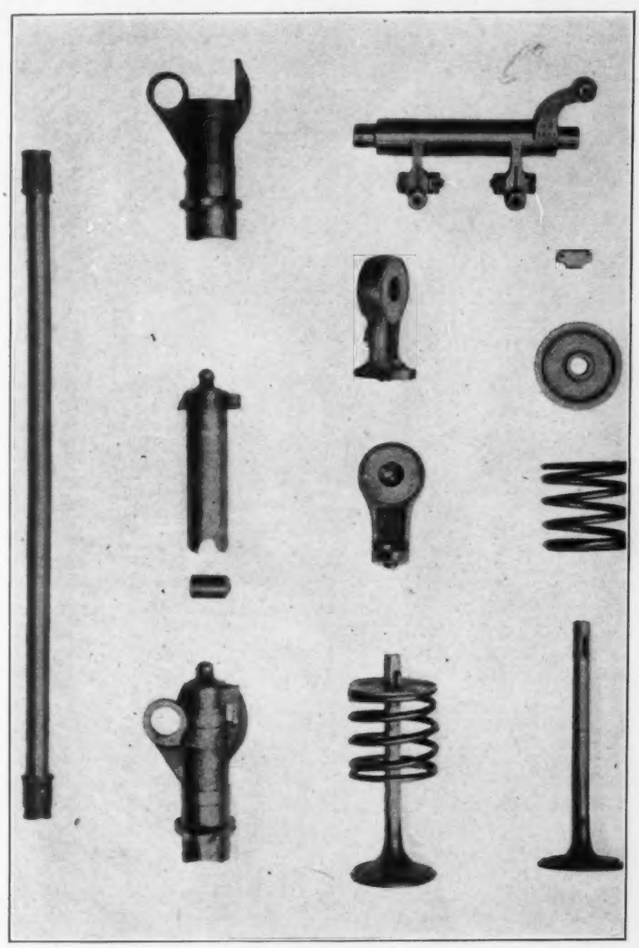


FIG. 9. VALVES AND VALVE GEAR PARTS

are made of cast-iron of a very soft nature. The effective bearing length of the floating bushes is 93 mm., and their external diameter is 44.3 mm. For lubrication purposes a number of 4 mm. holes are drilled and countersunk on the outside.

The protected area of the small end bearing surface on the gudgeon pin = 34.35 sq. cm., and the bearing surface in the connecting rod small end = 39.9 cm.

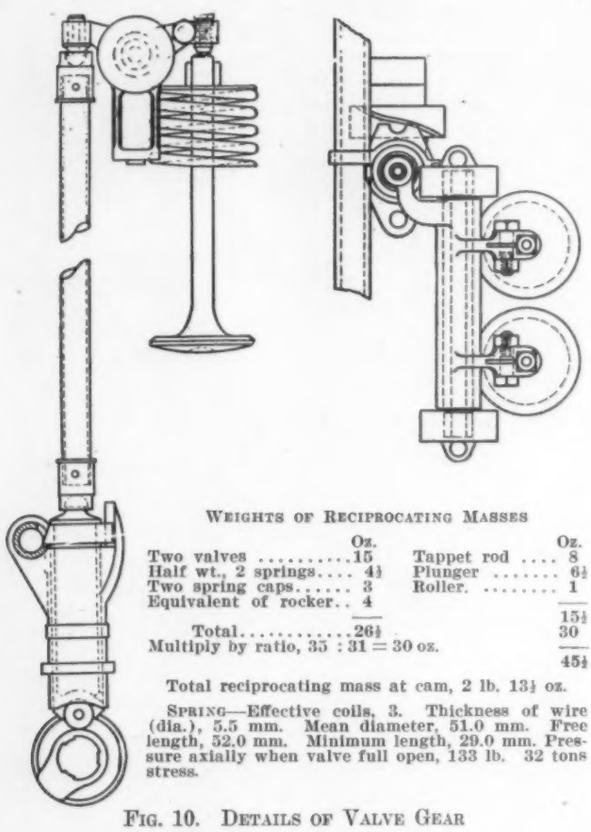
The weight of each gudgeon pin = 1.75 lb., while the cast-iron floating bushes weigh 0.62 lb. each.

Connecting Rods—Following the usual Maybach design, the connecting rods are of square section beveled at the four corners, and bored up the centre from the big end with a 28 mm. diameter hole, which is screwed and plugged as shown in Fig. 8.

The big end bearing cap is secured by four 14 mm. bolts, which are screwed 1.5 mm. pitch into the top half of the connecting rod big ends.

The inner surface of the big-end bearing shells are machined with a screw-cutting tool which leaves a fine pitch screw thread. This provides a serrated bedding for the white-metal lining.

No locking nuts are fitted to the big end bolts, but the square heads of the bolts are drilled, and prevented from becoming unscrewed when in position by a 4 mm. diameter pin, which is long enough to pass through the heads of each pair of bolts.



WEIGHTS OF RECIPROCATING MASSES

	Oz.		Oz.
Two valves	15	Tappet rod	8
Half wt., 2 springs	4½	Plunger	6½
Two spring caps	3	Roller	1
Equivalent of rocker	4		15½
Total	26½		30
Multiply by ratio, 35 : 31 = 30 oz.			45½

Total reciprocating mass at cam, 2 lb. 13½ oz.

SPRING—Effective coils, 3. Thickness of wire (dia.), 5.5 mm. Mean diameter, 51.0 mm. Free length, 52.0 mm. Minimum length, 29.0 mm. Pressure axially when valve full open, 133 lb. 32 tons stress.

FIG. 10. DETAILS OF VALVE GEAR

Two helical grooves 2 mm. wide are cut in the big end bearings. These oil grooves intersect each other on the centre of the bottom half of the bearing; the oil ways cut in the top half of the big end bearing metal are only taken half way on each side.

The little end floating bushes already referred to are lubricated by a 5 mm. steel pipe, which is fixed in the center of the hollow connecting rods, and the holes drilled in the floating bushes communicate with helical grooves cut in the small end. An annular groove is cut round the center of the small end bearing, which communicates with the central oil pipe. The method of securing this oil pipe at each end inside the rod and the steel disc which supports the center of the oil pipe in the bore are shown in the sectional drawing.

The total side clearance of the big end bearing between the sides of the crankwebs = 44 mm., and the float of the small end = 11.8 mm.

Total weight of the connecting and complete with floating bush = 8.93 lb.

Weight of big end = 5.625 lb.

Weight of little end = 3.305 lb.

Length of connecting rod between centers = 310 mm.

Valves and Valve Gear—The twin inlet and exhaust valves work vertically in cast-iron valve stem guides in the cylinder heads, and are operated by rocker levers mounted on roller bearings, each pair of valves being operated by a single tappet rod from one of the camshafts in the crankcase.

Valves—The heads of all the valves, both inlet and exhaust are of the same diameter—i.e., 54 mm., and the angle of the valve seatings is 30 deg. in each case.

The inlet valves are machined concave under the head, and are formed with a 20 mm. radius between the valve stem and the head. The exhaust valves are convex in the head, and are made with a compound radius between the valve stem and the head of 9 and 25 mm. The diameter of all the valve stems is 11 mm., the clearance in the guide bushes being .12 mm. (inlet) and .15 mm. (exhaust), cold. The ends of the valve stems are fitted with hardened steel discs, which are bedded in the recessed ends of the stems.

The inlet valves are 136.5 mm. long over-all, whilst the exhaust valves are 152.5 mm. in length. The exhaust valves are made longer to allow for the extra water cooling space in the cylinder head above the exhaust valve pocket already referred to.

All the valve springs, however, are of exactly the same length—i.e., 52.5 mm. free, and measure 39.5 mm. when in their position in the cylinder, initially compressed with no valve lift. The diameter of all the valve springs is the same, 51 mm. (central diameter of coils), and the gauge of wire is 5.22 mm. in all cases.

The valve springs are fitted with plain collar at the top. These are secured by T-shaped cotters through the valve stems in the usual way. These are also locked in position with small wire clips, which are fitted to the spring cotters through two small holes. The surface of all the valve spring collars is galvanized or plated with a tin or zinc deposit of some nature, apparently to prevent corrosion. This form of galvanized exterior finish is carried out on several other parts of the engine.

Details of the valves and valve springs are given in Figs. 9 and 10.

Valve Rockers—The roller bearings carrying the spindles of the valve rockers are mounted in short brackets, each of which is attached to the cylinder heads by two 8 mm. studs and castellated nuts. The bearing brackets are steel drop forgings, and the roller races are, to a certain extent, permanently fixed inside the recessed heads of the brackets, and are covered by thin steel disks fitted over the front faces of the bearings, these being held in position by a form of mechanical knurling largely used in German aero engine manufacture. This mechanical process takes the form of spinning or riveting over the housing metal of the part by a series of accurately spaced indentions. The effect of this work is shown in Fig. 9.

The hardened steel set screws for the adjustment of the tappet clearances are drilled with a 5 mm. hole in the center portion through the squared end only, and the usual form of transverse locking bolt is provided. The method of splitting the lever to provide for the locking of the tappet adjusting screw, however, is carried out in a somewhat unusual way. This is shown in the view of the rocker lever in Fig. 10, from which it can be seen that the saw-cut is made from the tappet hole, which takes the tappet adjusting screw backward through the center of the rocker lever toward the rocker spindle.

A steel stud having a hardened hemispherical end, which makes the top point of the valve push rod, is fitted on the outer lever of the valve rocker. These steel studs are driven tightly into the levers, and are secured by small steel wire rings snapped over semi-circular grooves cut in the top ends of the spherically ended studs.

The tappet push rods are made of steel tube 16 mm., outside diameter, and are fitted with hemispherical hardened steel cups at each end; these are fixed to the push rods by taper pins and weigh 0.48 lb. each.

The tappets consist of hollow steel tappet barrels which are plugged at the top ends by hardened steel caps; the tops of these caps are formed with hemispherical heads, which engage with the lower ends of the cupped push rods.

The hardened cam rollers are held in position by the grooves machined in the bottom ends of the tappet barrels; these grooves are made slightly more than a semicircle to prevent the roller from falling out. Side movement of the rollers is prevented by the tappet guides. The cam rollers are 15 mm. in diameter, and are bored with a 4.5 mm. hole.

Four small holes are bored radially in the sides of the hollow tappet barrels, which always carry a certain amount of oil, thus providing a very simple, efficient method of lubricating the tappet guides. These are made of gun-metal.

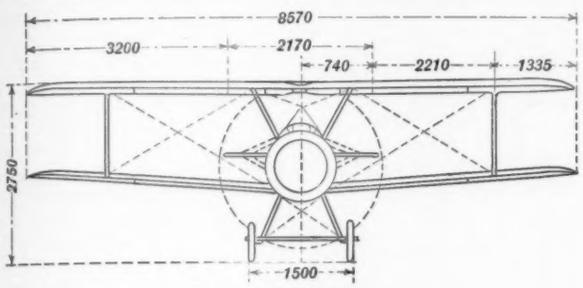
A vertical lug is provided on the top of each tappet guide, which forms the guide for the tappet barrel and prevents it from rotating. Three oil grooves are machined inside the tappet guides.

(To be continued)

The Sopwith-Clerget "Camel"*

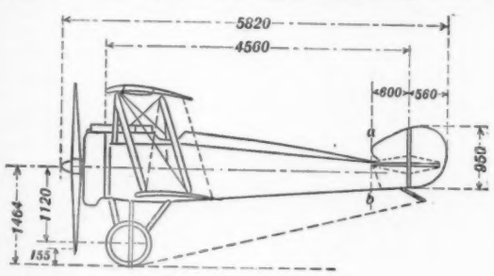
This machine, built by the Sopwith Aviation Co., Ltd., of Kingston-on-Thames, carries the designation F.1.B. 6290. It is a single-strutter machine and is a development of the Sopwith "Pup," from which, however, it differs in many details, apart from the greater power of its engine.

As in the older type, the wings and tail plane with elevator are of trapezoidal plan form, but the greatest span occurs at



FRONT ELEVATION

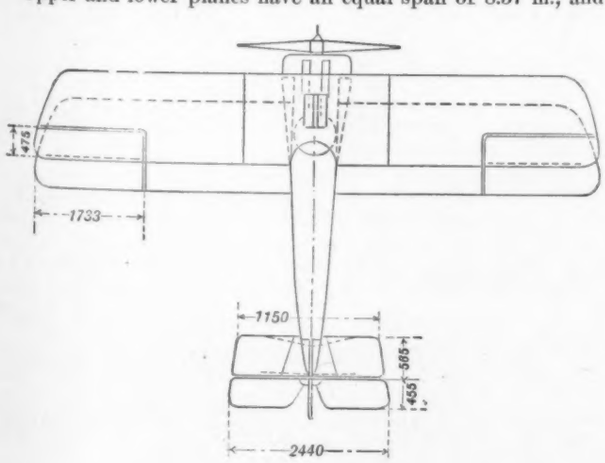
the trailing edge. The top plane center-section has a span of 2.17 m., while the strut attachments are only 1.48 m. apart. As the gasoline pressure tank and gravity tank are placed rather far aft, the pilot's seat is placed immediately behind the engine, underneath the top plane center-section. In order to provide a better view, a rectangular opening is cut in the



SIDE ELEVATION

center section. The longitudinal edges of this opening are provided with three-ply plates projecting beyond the wing profile so as to reduce the amount of air flowing over the edges. To facilitate getting into and out of the machine, the trailing edge of the center section has been cut away.

Upper and lower planes have an equal span of 8.57 m., and



PLAN

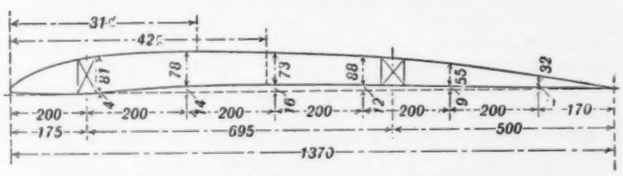
an equal chord of 1.37 m. The aspect ratio is therefore 6.25 against the aspect ratio of 5.15 of the older type.

* This description, translated from the German, is reproduced from *Flight*.

The wing spars, which are made of spruce, are spindled out to an I section, with the exception of the bottom rear spar, which is left solid. The gap between the planes is 1.31 m. at the tips and 1.52 m. near the body. (In the older single-seater the gaps were 1 m. and 0.86 m., respectively.) The upper plane is staggered forward 0.45 m. There is no sweep-back. The dihedral angle of the top plane is 178 deg. and of the bottom plane 170 deg. The angle of incidence of the top plane is 2 deg. at the center-section, 3 deg. at the tip. The bottom plane has a uniform angle of incidence of 3 deg.

The inter-plane struts, which are of solid spruce of stream-line section, are, as in all Sopwith machines, placed with their ends in steel shoes welded to the fittings on the wing spars, and are provided with no further attachment. The lift wires and landing wires, of which the former are in duplicate, are in the form of stream-line wires.

Non-balanced ailerons are fitted to the rear spars of both planes. The wing fabric, which is sewn on to the ribs, is cream-colored underneath, and the top surface, as well as the body fabric, is painted a reddish brown. The body, which is of the usual girder type with four longerons, has a rounded

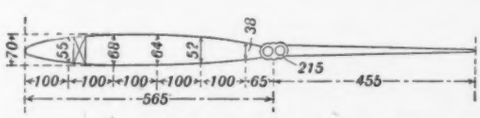


UPPER AND LOWER WING SECTION

top. The undercarriage is of the usual Sopwith type. A divided aluminum axle rests in a stream-line covering of wood. The axle hinges are braced from the body.

The tail plane, which is deeply cambered on both sides, is rigidly attached to the upper body longerons, with an angle of incidence of 1.5 deg. The tail plane trimming gear hitherto fitted to all Sopwith machines has been abandoned, in spite of the fact that the fuel tanks are placed behind the pilot's seat. The fin and rudder are of the usual characteristic Sopwith form.

The 130 h.p. Clerget engine, which is built by Gwynnes, Ltd., develops about 134 h.p. at 1200 r.p.m. According to a plate in the pilot's cockpit the revolutions of the engine are not to exceed 1250 r.p.m.



SECTION OF HORIZONTAL FIN AND ELEVATOR

The gasoline pressure tank has a capacity of 138 litres and the gravity tank holds 32 litres. This gives sufficient fuel for a flight of about 3½ hours' duration. An oil tank with a capacity of 30 litres is placed behind the engine. In some machines the tanks are of welded sheet aluminum, in others they are made of lead-coated, riveted sheet iron. The weight of the tanks is 12.5 kg. and 20 kg., respectively, giving a percentage weight of $\frac{12.5}{146} = 0.0832$ and $\frac{20}{146} = 0.133$, respectively.

In the pilot's cockpit are the following instruments, etc.:

In the center of the instrument board: Manometer, with safety valve, clock, pressure gauge, altimeter, compass, two switches, revolutions indicator, and pulsometer. On the right: The hand-pump (air). On the left: Control levers for pressure and gravity gasoline tanks, gasoline tap, throttle lever, gasoline lever indicator for pressure tank, Bowden cable for bomb release. A propeller air pump for the pressure tank is mounted on the starboard chassis strut. Two fixed Vickers guns are mounted on the nose of the body. Their locks and feed block levers are inside the body covering. Between them

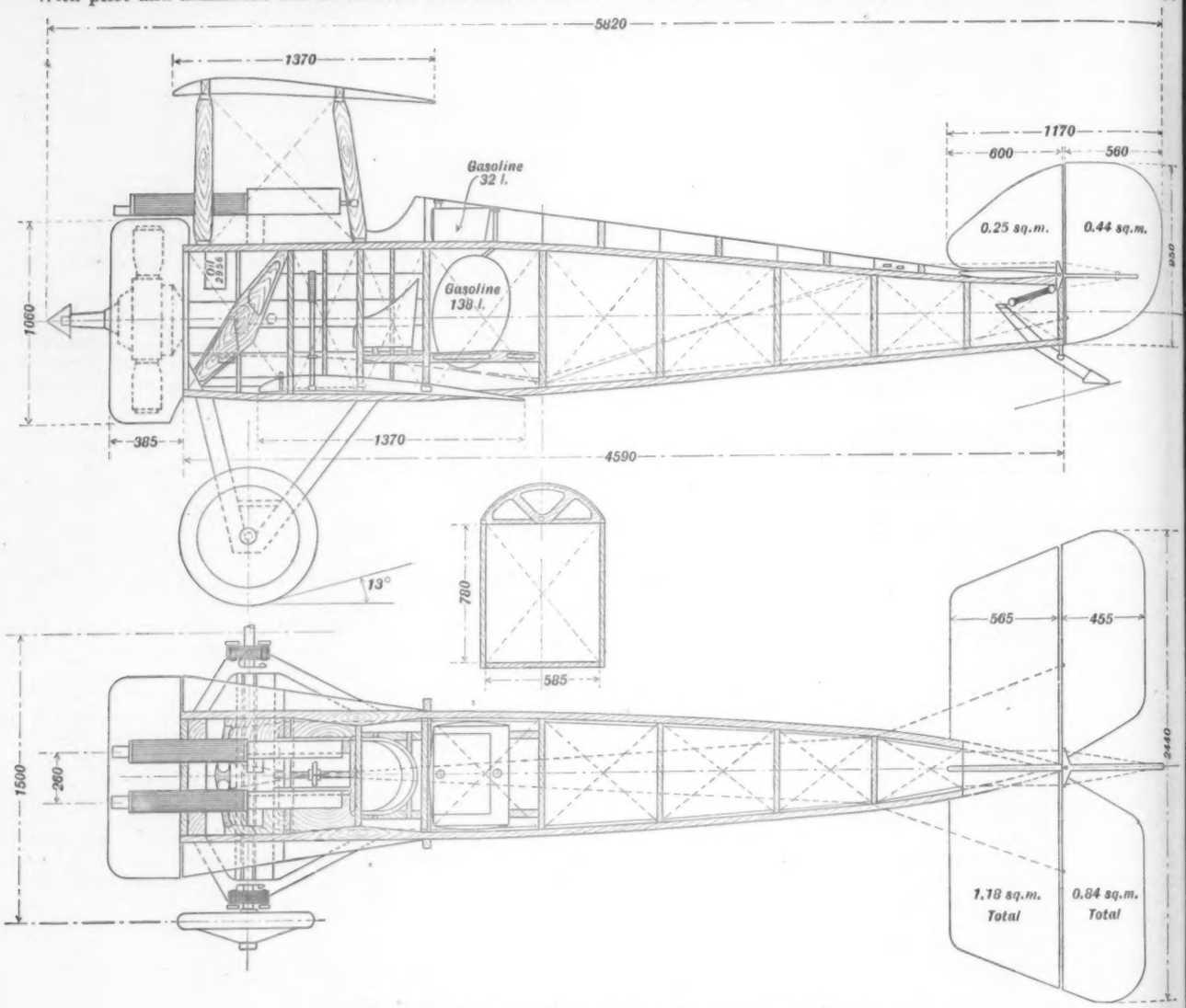
is a telescopic sight. In a bomb rack under the body can be carried four bombs, the Bowden controls for which are placed to the left of the pilot. There is no bomb sight fixed.

The weight of the machine empty was ascertained to be 430 kg. With tanks full the weight of the fuel is 150 kg. With pilot and armament the useful load would then amount to 290 kg. It is therefore to be assumed that the weight of about 50 kg. of bombs is only carried when the tanks are not full. Assuming a useful load of 290 kg., the total weight amounts to 720 kg. As the wing area is 19.76 sq. m., the wing loading is 36.5 kg. per sq. m., and the power loading is 720: 134 = 5.37 kg. per h.p. The corresponding loadings for the Sopwith "Pup" were 23.4 and 6.6, respectively. The "Camel" has therefore a higher wing loading, but a considerably smaller power loading.

Detail weights.—Engine, 159.0 kg.; airscrew, 18.0 kg.; tanks, 12.5 kg.; engine accessories, 12.5 kg.; body with aluminum covering, etc., 48.5 kg.; seat, etc., 9.0 kg.; undercarriage, 39.0 kg.; tail skid, 2.5 kg.; controls, 4.5 kg.; wings, 100.0 kg.; tail plane, fin, rudder and elevator, 13.0 kg.; fittings for armament, 11.5 kg.; total, 430 kg.

Weight of wings.—5.5 kg./sq. m.

Loading.—Pilot, 80 kg.; armament, 60 kg.; 4 bombs, 50 kg.; instruments, 5 kg.; fuel, 150 kg.; total, 290 kg.



DETAILED VIEW OF BODY IN SIDE ELEVATION AND PLAN

Aeronautical Patents

ISSUED AUGUST 6, 1918

1,274,501—To Sherman S. Benson, York, Nebr. Aerial bomb dropper.
1,274,679—To Everhard Richard Calthrop, London, England. Parachute launching device.
1,274,745—Harvey C. Mummert, Buffalo, N. Y. Airplane.
1,274,767—To Joseph Petit, New York. Hydroplane.
1,274,888—To Carl Alfred Johansson, Christiania, Norway. Stabilization of aircraft.
1,274,986—To Norbert Carolin, New York, N. Y. Airplane.
1,274,963—To George Louis Weber, Philadelphia, Pa. Flying machine frame.

ISSUED AUGUST 13

1,275,233—To Julius B. Ellinger, Seattle, Wash. Aircraft.
1,275,251—To Alfred Harb, New York, N. Y. Automatic flying machine.
1,275,445—To George J. Kocialek, Avoca, Pa. Aerial torpedo.
1,275,498—To John E. Thoroughgood, Sr., Edgecomb, Wash. Aerial life saving device.
1,275,710—To James N. Lewis, Detroit, Mich., assignor to Owen H. Fay, trustee, Chicago, Ill. Captive balloon controller and conveyor.
1,275,746—To James E. J. Rainey, Dallas, Tex. Airship.
1,275,973—To George C. Moore, Westerly, R. I. Running gear for flying machines.

ISSUED AUGUST 20

1,276,032—To Gregory Chmielinski, Chicago, Ill. Flying machine.
1,276,635—To Eldridge S. Foxworth, Glenmora, La. Airplane bomb.

ISSUED AUGUST 27, 1918

1,276,760—To Martin Hines, Brooklyn, N. Y. Flying machine.
1,276,778—To Paul Loveczky, Brooklyn, N. Y. Airplane.
1,276,993—To John H. Talge, Indianapolis, Ind. Structural member for airplanes.
1,277,036—To Francis E. Boland, Rahway, N. J., assignor to Boland Aeroplane & Motor Co., New York, N. Y. Aeronautic apparatus.
1,277,206—To George Fedchenkox, Detroit, Mich. Airplane.
1,277,260—To Peter Rosa, Tonopah, Nev. Airplane shock-absorber.
1,277,277—To Jesse Fernando Walden, Merryville, La. Airplane.

Production Problems of Aircraft Bolts, Screws and Nuts

By W. H. Sheahan

Factory Superintendent, A. H. & F. H. Lippincott, Director of the Y. M. C. A. School Airplane Construction, Director of the Aero Club of Pennsylvania

The successful manufacture of small parts required by the ever-growing aeronautical industry is one attended by much difficulty. One of the most exacting lines, known as small metal parts, requiring special equipment throughout in order to comply with the minute specified tolerances of the airplane builders who are constructing under Government inspectors, is the manufacture of the enormous quantities of machine screws, bolts, studs and castellated, as well as plain, nuts. Automatic screw machines of varying capacity and of the single and multiple spindle type play a most important role in the production of these parts; but owing to the accuracy of fit demanded by the specification and blue prints a large part of the work must be finished on hand machines.

One of the largest airplane builders specifies that all engine part studs, bolts and screws must be machined from the 3½ per cent nickel steel invariably used for the manufacture of all such pieces, with the threaded ends .001 in. to .002 in. over size; the pieces to then be heat treated to develop the tensile strength, and following this treatment the threaded portions of the piece to be die-sized to a basic pitch diameter with a tolerance of .002 in.

The nickel steel used by the aeronautic industry is undoubtedly one of the hardest steels to properly machine; it is of vital importance that no ring scores circle the bolt, stud or turnbuckle shank. This dangerous mark is cause for prompt rejection by the aeronautical inspector, who is as liberal in his views as his vocation will permit. Slight spiral scores, caused by the "back off" of hollow mills or box tools, will pass, but the ring score, sometimes caused by a failing tool or a caught chip, condemns any piece, no matter how good otherwise. Various difficulties are met and overcome in the die sizing to within the .002 in. tolerance following the heat treatment of the bolts and studs. This treatment increases the toughness of the steel from 50 to 100 per cent, and in practice it has been found that if the threads are machined the full limit of the oversize, on the first operation of threading while on the automatics, it becomes an easier proposition to die size to the tolerances required. If originally machined very close to finished size, the rethreading die has a tendency, owing to the extreme lightness of cut and the great toughness of the metal, to ride the already machined threads without cutting, and if set up closer to cut a chip, it will invariably "dig in," with the result of a thread several thousandth undersize and a loss of the piece.

Just why the airplane constructors specify the machining of threads after heat treatment is not clearly understood, unless it be to avoid the formation of scale in the threads, but this can be overcome in a very simple manner; and, while no reputable manufacturer will depart from the specifications of his customer, it is possible to produce bolts and studs of superior quality by threading to exact tolerances while the steel is in its most workable condition; and if heat treated in a proper manner there will be an entire absence of scale or oxide formation; while precision tests show absolutely no change in either pitch or outside diameter of bolt thread handled by this method. Ten test pieces were carefully micrometered at marked points after being fully machined to fine tolerances, heat treated without any presence of scale and without the variation of even .0002 in. from original size in either diameter or lead.

There is no question but what a thread of greater strength is obtained if the threads are fully machined before heat treatment; the "skin" surface not being cut away but remaining of the same toughness and great strength as the body of the bolt. There is also a decided saving in the cost of manufacture, due to the easier working of the steel before heat treatment. The saving on dies alone being an item large enough to bring this later process into general usage, as any saving in manufacture means lower prices and increased production, or quicker deliveries.

The successful manufacturers of nickel steel parts acceptable to the large builders of planes are but few. Many concerns have taken large orders based on estimates made without practical experience in the working of this material, with the invariable result that they fall down on their contract, and the airplane manufacturer is held up for delivery and in many cases is obliged to cancel orders placed in good faith at what seemed interesting figures; go out again into the market and make other contracts at much higher prices to secure prompt delivery for his urgent orders.

Manufacturers contemplating entering this field, who are without previous experience in machining nickel steel and working to the fine tolerances the aircraft constructor demands, would do well to carefully read "The Use and Abuse of Steel": a paper read before the Institute of Automobile Engineers of London, by Lieut.-Col. R. K. Bagnall-Wild and Lieut. E. W. Birch, and reprinted in *Flight* magazine. Information of vast importance is given in this article and in a later article in the same aeronautical publication the author sounds this warning: "A most important point at the moment is the output. The steel maker is using every endeavor to produce steel free from roaks, flaws and cracks, but it is a fact that in spite of care a quantity of faulty steel is delivered to the machine shop and sometimes a large amount of work is done on it before the defects are found. Detailed inspection can do a great deal to prevent such steel leaving the steel makers; numbers of examples can be put forward showing that much labor in this country is at present being wasted in machining faulty steel.

"One point of considerable difficulty has been experienced in the making of bolts, nuts and screwed parts. It is essential for airplane work that certain bolts should be made of alloy steel with a comparatively high tensile strength. Such steel is obviously more difficult, and in some cases almost impossible to thread in automatics. In the case of a steel which is used very largely for aeronautical work (of some 50 tons tensile strength) there is no doubt that it takes about five times as long to put through an automatic as common carbon steel, while the wear and tear on the dies is also much greater.

"It is considered that firms making screwed parts are to blame in not having realized this fact at an earlier date; but it is hardly fair to the designer for the manufacturer to complain after acceptance of a contract. It is obvious that bolts made of high tensile steel must be more expensive than those made of medium carbon steel. The screw makers should have tendered accordingly in the first place and not waste time in grumbling, and, what is far more important, in failing to give the output that he had promised."

These two short paragraphs state the entire case so thoroughly that it has been deemed wise to print them verbatim. Bolt makers who estimate on nickel steel products for the aeronautical industry, with the idea that two or even four times the automatic machining cost of the average carbon steel will allow a liberal profit, deceive themselves, for in addition to the five times cost as estimated by the author of the above article, various operations are necessary that are entirely overlooked by the manufacturer who is without the nickel steel experience. Heads of bolts must in every case be "burred" to clean it of the needle like points left by the cut off tool of the automatics. In many cases when heated treated stock is supplied to the manufacturers the toughness of the material is such that not only the top but the six sides of the hexagon head must be burred to produce a clean piece of work, and as an extreme case, the writer has in mind certain material furnished for machining which it was impossible to cut without regrinding the form tool after each two or three pieces were machined. "Stellite" tools were tried as a last resort and after their failure to do the work the job was abandoned and the material returned to the customer for analysis and investigation.

These cases are cited in order that the manufacturer whose experience has been entirely confined to a cold rolled carbon steel product, with the very liberal or entire lack of any set

tolerances of accuracy, or who manufactures a product by the rolled thread instead of die cut process, will fully understand that the present accuracy required by the airplane constructors is a bolt that must stand the rigid test for tensile strength, the body must be almost unmarked to guard against weakness, the body size must not exceed the diameter given, must not exceed 0.004 in. undersize, the pitch diameter must not exceed even by 0.001 in. the basic size nor fall 0.002 in. below and in all its other measurements the finished piece must not be over 0.005 in. or under 0.005 in. from the sizes given on the blue print.

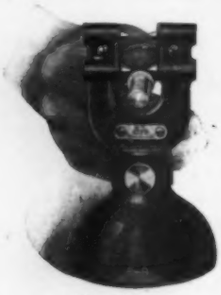


FIG. 1

Constant care, careful gaging and rigid inspection at all stages of manufacture are necessary to produce work to the standards set by the constructors. Gages themselves must be periodically checked with master gages, for, after thousands of pieces are gaged, male plug gages wear tapered and must be discarded; templet or female gages wear large and must be reset; all of these items enter into the cost and selling price of the plant's production.

While the manufacture of bolt nuts is not attended by the many difficulties of the manufacture of the bolts, it is not the simple process it seems. The standards of accuracy are just as rigid, and any perceptible shake when nut is tested on standard thread gage rejects same. The tapped size should in no case exceed the basic pitch diameter by more than 0.002 in. in the larger sizes, and in the extremely small nuts 0.0005 in. is a liberal enough tolerance to insure perfect fit. When working in the smaller and even medium size nuts, the tapping operator must be ever on the alert and change taps the instant the wear reduces it to the basic pitch diameter, as nuts, even the minutest fraction under nominal, become "scrap" unless the quantity is sufficiently large to warrant a second rethreading to redeem same. The sorting out, gaging and retapping is an item of expense almost as great as the original manufacture.

The majority of airplane nuts are usually castellated for spring cotters; as the castellation of these pieces on the automatics (which are sometimes provided with such an attachment) is an extremely slow process, retarding the proper production or speeding up of the machines, these pieces are usually run plain on the automatics and castellated on other machines as another operation; by this method full production by speeding up the automatics to its limit can be procured, and in properly designed castellated machines of the disk or dial type the second operation is fully offset by the greatly increased production. It is of importance that the castellations be central, in line and of uniform depth; if such is not the case, the spring cotter is blocked from entering properly, for there is but the slightest allowance over diameter of cotter.

The selection of proper size tap drills is important, since large rejections of nuts are liable to be made if a drill slightly oversize is used. "Flat threads" are instantly rejected by the inspector of airplane material, and the manufacturers will do well to keep to a drill which will give a full three-quarter thread rather than less. The following facts regarding nuts are of interest: a common nut drilled out so that it contains only 50 per cent of a full-depth thread will break the bolt before it will strip. A 75 per cent depth of thread yields an ample margin of safety (2 to 1), and is economical in tapping. A full depth thread in a nut is only about 5 per cent stronger than a 75 per cent depth of thread, yet it requires three times the power to tap.

While the above rules do not apply to bolts of nickel steel, yet for all purposes a thread 75 per cent depth carries an ample factor of safety and prevents excessive tap breakage. One of the most serious drawbacks in the connection with the manufacture of airplane nuts is the fact that there are no commercial taps on the market the proper size to tap to the fine tolerances demanded. Owing to this fact, and because also commercial taps run oversize, even in the same lot, from .002 to .005 in., the nut manufacturer is obliged to make his own taps or order special taps from the manufacturers, in which case the usual delay attendant to special goods applies with no assurance as to when deliveries will actually be made.

The selection of the proper steel for tap making is important, and the best results are obtained by using a tap steel containing a small percentage of tungsten or a vanadium alloy steel of 0.25 to 1 per cent vanadium; in both cases the carbon contents to be the same as regular carbon steels used for this purpose.

These steels are liable to show a slight shrinkage of possibly 0.002 in. per inch in hardening. In the case of nut taps this so slightly affects the lead that for the short depth or thickness threaded, no account need be taken of same. Other steels are obtainable which are non-shrinkable in an oil-tempering bath, and the cost of these steels is not excessive. One of the peculiarities of the non-shrinkable steels is the fact that it usually lengthens in hardening, approximately 0.002 in. to an inch of length. Certain tap steels are also on the market which are moderate in cost and which show no appreciable change in size when hardened.

For the correct gaging of nuts, the male thread gage of nominal size on one end and a plug root of thread gage on other end is recommended. A careful gager with the root size plug soon learns to detect a flat thread piece, while on the thread end of gage the nuts should fit "snug," but capable of being run on flush with end of plug thread with the fingers; nuts should not be forced on gage, as this causes excessive wear and short life of an expensive tool, and one that under present circumstances is hard to replace, as the entire gage-making industry is being worked to their full capacity with tremendous orders ahead.

The report of the screw and nut sub-committee of the S. A. E. Standards Committee have recommended that the S. A. E. airplane bolts, not for engine use, be made with a tolerance of 0.004 in. minus from nominal size. This is a liberal tolerance, and it is better for the bolt maker in gaging his product to leave this outside diameter size to the accuracy of his machines and gage the production by thread limit snap gages, which accurately and rapidly check the pitch diameters of screw threads. These gages are made with two carefully ground points, the cone surfaces of which accurately fit the thread walls and are offset one-half the pitch of the thread; the diameter of the screw is thus taken directly from the pitch diameter at which point it is most important to have as small a tolerance as possible in order to secure snug-fitting bolts. In this style of limit gages, the hardened cone points are made adjustable by set and locking screws, and, after being set by means of the maximum and minimum setting plug, it is advisable to seal same to avoid the possibility of any change being made by some one not in authority. It is advisable to work with these snap gages set to a tolerance of but 0.002 in., setting the upper set of cones to basic pitch diameter and the lower cones to minus 0.002 in. Threads of bolts and screws can be accurately and quickly gaged, in fact, almost as quickly as they can be handled by placing the threaded end in the gage and letting the weight "tell the tale."

FIG. 2

Handled as shown in the accompanying illustrations if the bolt passes both set of points as in Fig. 1 it is too small and should be rejected; if it will not pass through upper points as in Fig. 2 it is oversize and should be laid aside for a final die sizing to bring within the limits. If the piece passes the upper set of cones and rests on lower, as shown in Fig. 3, the pitch diameter is within the tolerances and a more accurate fit is obtained than when the manufacturer works by gaging only the outside diameter of the threads, depending upon the die to produce the proper pitch diameter. Fig. 4 shows the proper method of handling screws and bolts by this method of gauging, the weight of the piece governs the touch or "feel" and when used in this way there is no forcing of pieces through the gage.

This method of gaging has many advantages over the templet gage and in addition to the pieces being handled in a much faster manner, the results obtained are superior as the checking is the same as obtained by using thread micrometers, with the exception that no reading is obtained. A further advantage is that it can be handled by the most in-

experienced workman to whom a micrometer remains a mystery, sometimes forever, and its use in the hands of such workmen is always attended by the tendency to make the "mike" fit the work by not closing up fully, if undersize, or slightly forcing the piece through, if oversized, with the added possibility that the measurements will be misread. Thread limit snap gages are positive, the results are good and while the cost is in excess of thread micrometers, their many excellent features offset the extra cost: in a shop they are less liable to be looked upon as personal property by the workman using same.

FIG. 3

In conclusion, it is but fair to state that for good work in the bolt, screw and nut line the airplane builders will pay prices profitable to the manufacturer. In return for same each and every piece must be within the tolerances laid down on the blue print. The manufacturers must not ask, neither will they be granted permission, to deviate therefrom: there is no appeal from the airplane builder's inspector of material and unless one has had vast experience on precision work and the inspecting and gaging of same, it is advisable to confine one's efforts to a line of work less exacting.

The average bolt and nut maker manufacturing his products, the bolts by the heading process and nuts by the punched method, is absolutely unfitted for this line of work. Manufacturers of machine screws which are made on screw machines that roll the threads and put on the heads automatically will find that there is more profit in continuing their regular line than in taking contracts for airplane bolts and screws, which are invariably turned from solid stock on automatic machines. The material is difficult, if not at times almost impossible to obtain, and is four to five times as difficult to machine as the ordinary carbon steel; furthermore, after it comes from the automatics it is but very little more than half finished. The expenses of burring, die sizing, inspecting and heat-treating, followed by the usual copper and nickel plating as a rust preventive, practically double the cost beyond the machining stage.

FIG. 4

After the general inspection the pieces are counted, boxed and tagged with the ever familiar tag: "U. S. Government War Material, Do Not Delay" marked for Some Airplane Co. Somewhere in America, and away goes the precious cargo to its destination.

Some New Enemy Airplanes

The Zeppelin Giant Airplane—*Concluded*

Interplane Bracing—The interplane bracing is clearly imitated from the 1914-16 Bréguet bomber, and consists of three cabanes—one, amidwings, on the body, and one, on each side, for the engines—and of three pairs of interplane struts. Each cabane is composed of two A-pieces of steel tubing, the summits and bases of which are fixed by means of sleeve joints to the wing spars and upper body longitudinals, respectively. The A-pieces are steel tubes of 55 mm. I.D., except the rear tubes of the engine cabanes which are 60 mm. in diameter, while the cross-pieces are of 32 mm. I.D. The base of the A-pieces of the engine cabanes is reinforced by a compression tube, which is carried inside the wing and is bolted to the sleeve joints.

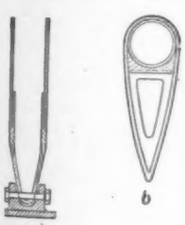


FIG. 10

The interplane struts are round steel tubes varying in diameter from 55 mm., amidwings, to 35 mm., at the tips and are streamlined with plywood fairings built over internal ribs. (Fig. 10, *a*). The struts are bolted into lugs against which they rest through compression (Fig. 10, *b*), while the lugs are fixed to a sleeve joint of sheet steel, which surrounds the wing spars.

To avoid distortion of the struts an almost horizontal tube links at mid-height each front strut with the strut behind in the same pair.

Wire bracing—Outwardly the wire bracing is of the usual type, consisting of diagonally crossed wires. However, by a disposition peculiar to this machine, and general in the bracing in other directions (except transverse) of its body, each transverse cable of the wings as well as in the stabilizing planes is formed of an endless cable. Or, more exactly, after it has been passed diagonally round three faces of the wing spar, without having been linked to a fixed point, but passing simply in a groove welded on to the spar sleeve joint, one of the ends of the cable returns from the opposite side toward the other end with which it is linked by the turn-buckle (Fig. 11). It is thus, in a sort of way, doubled, but although weighing double, it does not offer double strength.

Undoubtedly this system ensures a certain elasticity from which the machine and the cable itself profit, but if a rupture occurs the entire cable ceases to fulfill its functions, because, having no point of attachment, it slacks off and offers no resistence to strain.

A set of cables of which one end is fixed at the bases of the engine cabanes runs transversely at half their height from the internal struts to the external struts, and thence terminates into two leads at the wing tips, thus linking up by cable the ends of the horizontal inter-strut tubes already mentioned.

At the crossing of these cables with the transverse bracing

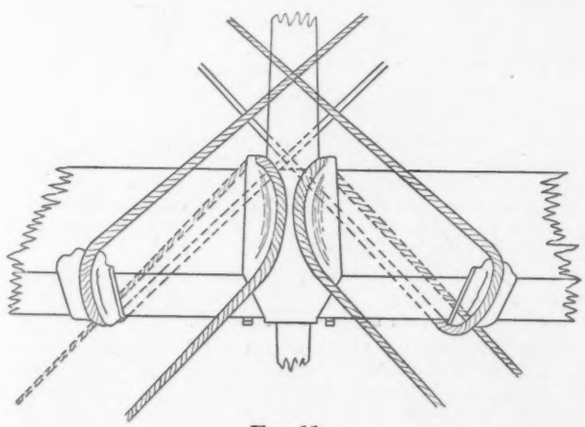


FIG. 11

cables, the cables are enclosed in a little fairing of poplar profiled in the form of a hollow olive. All the cables, including the double transverse cables, are enveloped in a fairing of light ply wood surrounded by glued fabric.

Ailerons—As in all German biplanes, except the Albatros C-class and the Friedrichshafen, ailerons are fitted to the upper wings only. They are not balanced, which seems singular in view of the size of the machine, and the corresponding effort required for controlling it; their framework is entirely built up of steel tubing. The crank levers are of sheet steel; they are lodged in the thickness of the wing, and are controlled by cables.

Steering gear—This consists of a biplane tail and three rudders, the latter being mounted in between the two horizontal planes. The size of this cellular structure is truly enormous, if compared to the steering gear of current size machines, there being sufficient surface to the biplane tail to make of it a small two-seater machine.

Horizontal Fins and Elevators—The most remarkable feature of the horizontal fins is that they constitute aerofoils of

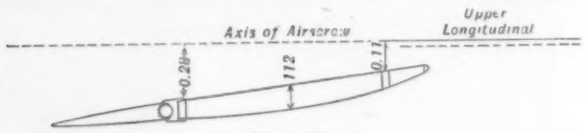


FIG. 12

reverse camber, or to be more correct, their upper face is flat, while the lower face is convex (Fig. 12). The maximum depth of these fins is 112 mm. Structurally they are similar to the wings: the spars are of spruce, wrapped with fabric, 40 mm. wide by 85 mm. high; the ribs have spruce webs and poplar flanges; each half-plane has two compression tubes. The inter-fin truss consists of a cabane of two inverted V-pieces of steel tubing, which is fixed to the top of the body, and, on either side, a pair of vertical struts which are *duraluminum* tubes—a considerable novelty. The forward V of the cabane rests on a transverse piece supported by two threaded steel tubes, on which it is adjustable by means of fittings held between set screws. The incidence of the fins may thus be changed at will, though this involves the simultaneous setting of both fins. The wire truss is similar to that of the wings. Drift wires are carried from the body to the forward summit of the cabane, and to the rear inter-fin struts.

The elevators, of one piece each, are secured to the rear fin spars by eight hinges. The ribs are built up of duraluminum lattice ribs of U-section and are wrapped with fabric, onto which is sewn the surfacing fabric. (Fig. 13.)

Vertical Fins and Rudders—There are three vertical fins and three rudders. The central fin is secured to the horizontal fins by two vertical duraluminum tubes, occurring between the V-pieces of the cabane, around which it is, so to speak, built up. This fin has a triangular portion, extending forward beyond the horizontal fins, which terminates at one of the body

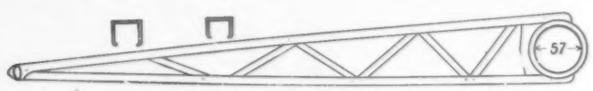


FIG. 13

formers. The two lateral fins are mounted on the duraluminum inter-fin struts, on either side of the tail cabane, at about 3.50 m. from the centerline. All the fins have a triangular cut-out, to allow for the balanced portion of the rudders; the latter are hinged to the rear inter-fin struts and the rear vertical cabane tube, respectively.

Constructionally the vertical fins and rudders are similar to the elevators, and are built up of duraluminum lattice ribs, even the crank levers being of this metal.

Body—The body is a lattice girder of rectangular section, and not, as is the latest German tendency, a plywood shell. The upper longitudinals are of spruce, the lower ones of ash; they are 75 mm. high by 80 mm. wide amidwings, whence they taper down, nearing the tail, to 47 mm. height by 75 mm. width.

Each longitudinal forms a box spar, the composition of which is shown in Fig. 14*a*; however, at the points where the strut fittings and wiring plates occur, the spars are full. The spars are wrapped with fabric over their entire length.

The maximum cross-section of the body, from behind the pilots to the gun-turret, is 1.80 m. wide by 1.68 m. high, as measured between longitudinals; the latter are, however, fitted on their outer edge with small spacing strips of poplar, which answer the purpose of keeping the surfacing fabric clear of cables, turnbuckles, etc. (Fig. 14, *a*.)

At the rear end each upper longitudinal is fixed to the corresponding lower longitudinal by two sheet-steel clips, of which the rear one carries the lower elevator hinge tube. The longitudinals reach only to a point above the forward chassis, where they are interconnected by two inclined 55 mm. steel tubes, and whence the nose of the machine constitutes a separate structure which might be disconnected from the body.

Body Formers—These are of two types. From the nose to the gun turret they are entirely of welded steel tubing (*B* to *I*, Fig. 3), which is so arranged as to leave a passage way in the middle, while from the gun turret to the tail the formers are tubular frames which are assembled, except at D, by corner clips of sheet steel. Ordinary cross wiring is used, lugs being welded for this purpose to the tubular frames. The system of securing the body longitudinals to the formers, by means of sheet steel fittings, may be gathered from Fig. 14, *b*. Unlike the transverse bracing of the body, which is of the diagonal type, the longitudinal bracing is composed of endless cables.

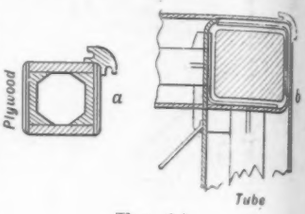


FIG. 14

Internal Arrangements—The crew of the machine appears to be composed of eight or nine persons. In the forward cockpit there is room for at lease one gunner-observer. Behind him, in a raised position so as to afford a clear view over the forward cockpit, are seated side by side two pilots, and to the rear of the latter a wireless operator. Then, on a level with the leading edge of the planes, are seats for two mechanics as well as the fuel tanks, between which there is a passage way, while the bombs are fixed amidwings underneath the body. Finally, in the gun turret, aft, there are at least two machine gunners.

The body is almost entirely covered with fabric, only the nose being covered with plywood, while a portion of the back, forward, is aluminum-plated.

Armament—There are at least four machine guns on this machine, and possibly six. One of these is mounted on the forward cockpit, while two guns are fitted to the spacious gun turret, aft, and one seems to have been fitted for firing downward through a trapdoor in the body. Possibly additional machine guns have been mounted on the machine, particularly on the gun turret, but no trace of these has been found.

There are, apparently, only two bomb gears, but each is for a 1,000 kg. bomb, and these are suspended amidwings, underneath the body by means of two collars which are fixed to the wing spars.

Power Plant—This consists of four 300 hp. Maybach engines, which are mounted in pairs, end to end, on either side of the body, in suitable housings. The pusher airscrews turn

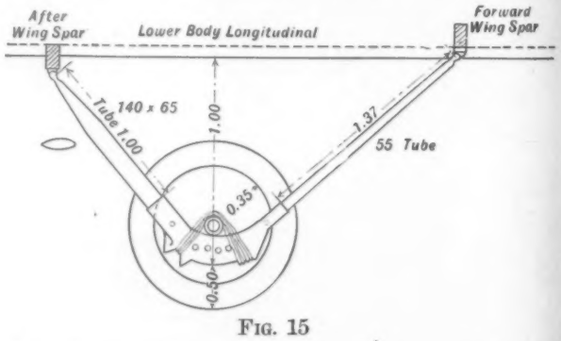


FIG. 15

around the same axis as the tractors, but in opposite directions, since all the engines are of the same model. The engine bearers are of composite wood (ash and veneer), and are supported by the tubular A-pieces previously described as well as by inclined thrust tubes abutting by way of the wing spars against the main undercarriage struts.

The airscrews are 4.30 m. in diameter, and are made of wooden laminations, the whole being covered by a thin layer of plywood. They are driven by means of a transmission system consisting of a leather-lined cone clutch, a short transmission shaft, and a speed-change gear box. A flywheel of 0.40 m. diameter is mounted between the engine and the clutch.

Undercarriage—The undercarriage is of the type usually found on enemy multi-engine bombers, consisting of three sets of wheels supported by V-struts, two being underneath the

engines, and one the nose of the machine. In the main undercarriage the struts are round steel tubes, and are welded into an elbow-piece fitted with notches for holding in place the rubber shock absorbers; they are attached to the interplane strut sleeve joints of the wing spars by means of ball-and-socket joints (Fig. 15). The axle is a 110 mm. steel tube, and carries at each end two pairs of twin wheels of 1 m. overall diameter. The tires are 700 mm. by 120 mm.

The forward undercarriage is similar to the one described, except that it is of much smaller size, and the struts are bolted to the body longitudinals.

The tail skid is a single piece of ash, 1.20 m. long, and is pivoted around a lower body cross strut; the latter is reinforced longitudinally and transversely by compression tubes.

Controls—These are of the general Dep type and are dual. The control lever is a duraluminum tube which is plugged with wood at the base only.

Weight items—Assuming the gross weight to be 12,600 kg., the upper wing spars must work under a fairly high stress. The most high-stressed part, situated just outside the engine housings, works at 1.7 kg. per sq. mm., while the lower spars work at 1.3 kg. per sq. mm. As to the interplane struts, these work at from 1.1 to 3.8 kg. per sq. mm., while for the cables the figures vary from 10 to 25 kg. per sq. mm.

The gross weight being 12,600 kg., the wing area 314 sq. m., and the horsepower 1,200, the wing loading would be about 40 kg. per sq. m., and the power loading, 10.5 kg. per hp.

The A. E. G. Armored Airplane

A few months ago considerable prominence was given in the daily press to the appearance on the Western front of a German armored airplane, styled a "flying tank," which its alleged invulnerability was supposed to make a terror of the skies. A machine of this type, which was brought down in the British lines on May 16, 1918, is described in a report recently issued by the Technical Department of the British Air Ministry, from which it appears that the so-called flying tank is an A. E. G. biplane, which is designed for offensive patrols against infantry, and is fitted with armor for the protection of its crew.

In general construction this machine closely follows the lines of the A. E. G. twin-engined bomber, described in the July 15, 1918, issue of AVIATION AND AERONAUTICAL ENGINEERING, the main difference residing in the power plant, which is a 200 hp. Benz. Steel tubing is used practically throughout in the construction of the A. E. G. machines, including wing spars and engine bearers, but excluding the main ribs, though there are some subsidiary ribs of light gage steel tubing. Therefore, outside of minor details, the new A. E. G. biplane presents particular interest only on account of its armor and its unusual armament.

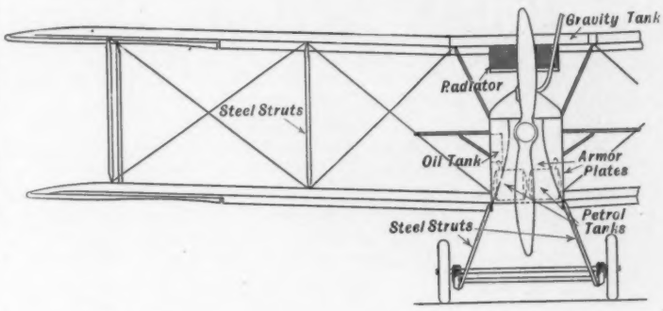
Armor—The disposition of the armor is shown in the accompanying side elevation in thick lines. There are three panels at each side, and three panels at the bottom of the body, an armor bulkhead being placed at the rear of the gunner's cockpit to protect him from behind. The armor is 5.1 mm. thick, and its total area is 105.8 sq. ft. The weight of the armor is thus approximately 860 lb. Careful tests have been made to ascertain the effectiveness of this armor, and the following table gives the ranges at which these plates are safe or unsafe against penetration by bullets of various types. These figures may be taken as correct within the limit of a practical firing test.

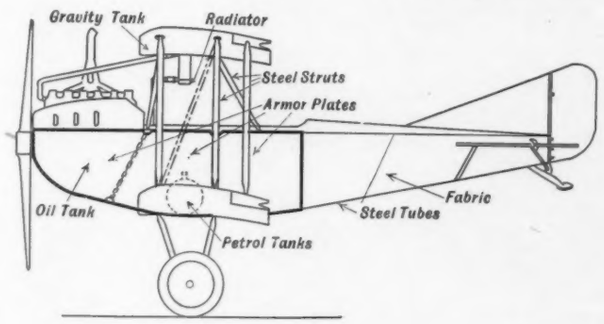
Ammunition.	Angle to Normal, Degrees.	Safe Range, Yards.	Unsafe Range, Yards.
German A.P.	0	—	600
	15	500	400
	30	400	300
Mark VII. P.	0	probably 700	600
Armor piercing	15	400	300
	30	300	200
German Spitze	0	150	100
	15	100	50
	30	50	
Mark VII	0	50	
	15	50	
	30	50	

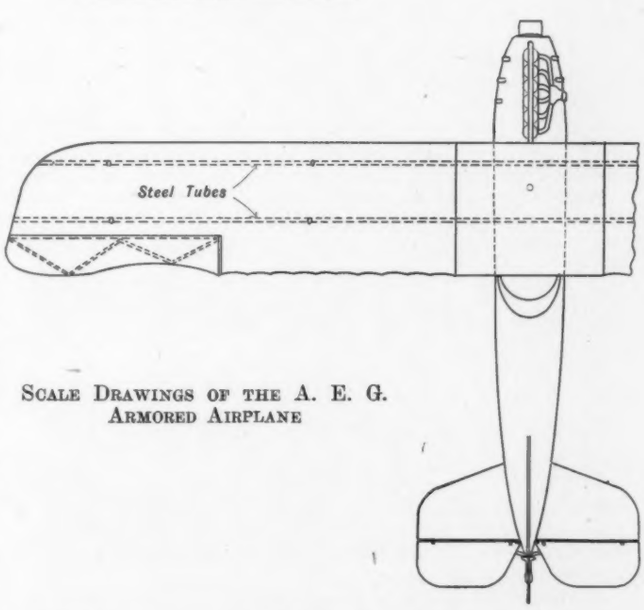
The armor is undoubtedly too light to afford protection against British armor-piercing bullets fired from the ground at a lower height than 500 ft., while a machine armored with it would have to fly at, at least, 1000 ft. to be safe from all but a very low percentage of hits.

The armor does not appear to have been employed, as it might well have been, in a structural capacity—i.e., it is simply an attachment to the framework, to which it adds no material strength. Its appearance seems to point to the fact that it had been added by way of experiment, and that it was of a more or less makeshift character. It had, for instance, evidently been necessary to open out existing holes and cut new holes in the course of erection. The armor is attached by set screws to clips clamped on the members.

Armament—In this machine the pilot is not provided with a gun, but the observer has to control three, of which two







SCALE DRAWINGS OF THE A. E. G. ARMORED AIRPLANE

(Spandau) are fixed on the flooring of his cockpit, whilst the other (Parabellum) is carried on a rotatable mounting.

With regard to the fixed guns, these are secured to a couple of tubular steel brackets welded to a steel base. Adjacent to these two guns, which fire forward at an angle of 45 deg., is a bracket carrying the belts of ammunition, which are fed from a large rotating drum.

In the right-hand front corner of the pilot's cockpit floor is a circular hole, which he would appear to use for sight purposes. The fixed guns are controlled by Bowden wires and triggers mounted on a diagonal frame member, convenient to the gunner's right hand. With regard to the movable gun, this is of the Parabellum type, and the mounting is of the usual

built-up wood variety. The vertical carrier is swivelled at its base, and is secured in position by sliding bolts engaging with teeth cut in the turned-up base plate. These sliding bolts are worked by a direct acting thumb lever.

The principal characteristics of the machine are as follows: Area of upper wings, 190.4 sq. ft.; area of lower wings, 168 sq. ft.; total area of wings, 358.4 sq. ft.; area of upper aileron, 11.2 sq. ft.; area of lower aileron, 10 sq. ft.; area of tail plane, 9.4 sq. ft.; area of fin, 7.6 sq. ft.; area of rudder, 6 sq. ft.; horizontal area of body, 48.6 sq. ft.; side area of body, 54.8 sq. ft.; cross sectional area of body, 14.4 sq. ft.; area of side armor, 33 sq. ft.; area of bottom armor, 29.4 sq. ft.; area of armor bulkhead, 10.4 sq. ft.

Crew—pilot and gunner, 360 lb.; armament—three guns; fuel capacity, 38 gall.; oil capacity, 3 gall.

(*To be Continued*)

British Advisory Committee Report for 1917-8

Following is an excerpt from the 1917-18 report of the British Advisory Committee for Aeronautics:

There has been no diminution in the number and complexity of the problems with which the Committee has been required to deal. Owing to the war the technical development of aeronautics has been extraordinarily rapid. The feats that are now performed in the air, and the capabilities of modern machines, are remarkable when it is remembered that it is very little more than ten years since the brothers Wright made their first flights in Europe. It requires little imagination, however, to realize that much greater developments are to be expected, and the competition of modern warfare renders it vital that the highest possible rate of progress should be maintained and that development should be pushed forward with the utmost speed. It is by no means easy to decide upon the method of attack best calculated to win ground quickly. The needs of the moment are in many cases imperative; immediate difficulties must be solved in order that construction may not be hampered and that supplies for the services may not be held up. It is, however, not less important to take a long view, and to secure the substantial improvements that are more likely to result from systematic and continuous research. The need of systematic investigation in this or that direction is being continually impressed upon the Committee by the questions with which it is confronted. To render it possible to carry out such continuous investigation quickly and at the same time to meet immediate needs it is necessary to multiply facilities for experiment, and the Committee has had again to press for increased provision for experimental work. Happily, the fundamental importance of such research in connection with aeronautics is well established and undisputed, and as on previous occasions the needs urged by the Committee have been fully realized by the executive authorities, and their proposals have been strongly supported and carried through with the least possible delay. A channel for model tests is available at the Royal Aircraft Establishment, and this is being employed, so far as possible, for specially urgent work.

Experimental Work at the National Physical Laboratory—Proposals for additions to the buildings and equipment for experimental work at the National Physical Laboratory have recently been made; the construction of these is in hand and will, it is hoped, be completed at an early date. Two new channels are to be provided, one similar to the existing 7-ft. channels and one of special type. The design which has been adopted for the latter has been completely worked out by experiments on model channels, and while based on the same principle as was applied in designing the earlier channels, exhibits some interesting modifications in detail, which may be found generally valuable in future in channel construction. The buildings to be provided will contain also additional workshop and office accommodation.

Modifications of the existing equipment made during the past year embody the results of experience as regards the most accurate and the most expeditious methods of conducting the experiments. New methods have been perfected for measuring the drag on models in cases where this is very small and where consequently the highest accuracy is necessary if the results are to be of value, especially when a considerable change of scale is involved in passing from the model to the full-sized aircraft. Special apparatus has been designed for vertical force measurements, and for experiments on propellers and propeller interference. New apparatus has been constructed for the determination of rotary derivatives. Improvements have been introduced in existing methods of measurement, and every effort has been made to secure ease and rapidity of working, consistently with the maintenance of the requisite accuracy. In the Engineering Section special apparatus has been constructed for dealing with particular problems, among which may be mentioned the apparatus for impact tests at high temperatures of specimens of aluminum alloys.

Experimental Work in Aerodynamics—In April, 1917, a Sub-Committee was appointed to consider the relation between full scale and model results and to examine into certain special questions which appeared to present difficulty. This Sub-Committee held eleven meetings and received thirty-one special reports. In the course of their investigations they found it necessary to arrange for a considerable amount of experimental work both at the National Physical Laboratory and at the Royal Aircraft Establishment, while valuable assistance was also derived from reports made of the performance tests at other air stations. The information available was not sufficient to enable general conclusions to be reached as to scale effect, for which investigation extending over a long period will doubtless be necessary, but the results brought out were of great interest, and to a large extent cleared up existing difficulties. The Sub-Committee reported in December, 1917, and their report will shortly be ready for issue among the confidential papers of the Advisory Committee circulated by the Technical Department (T.5). Following a recommendation made by this Sub-Committee, the Aerodynamics Sub-Committee, to which reference has already been made, was appointed in the same month and now sits regularly for the discussion of aerodynamics problems of special importance which arise in relation to aircraft. This Sub-Committee includes among its members representatives of the Technical Department and of the Services as well as of the National Physical Laboratory and the Royal Aircraft Establishment. Reports will be submitted to them of experimental work carried out at Service Air Stations, and arrangements have been made for securing the attendance at meetings of the officers in charge of such experimental work, in order that the Sub-Committee may have the fullest possible information on the matters dealt with.

A large amount of interesting and valuable work has been carried out during the year both at the National Physical Laboratory and at the Royal Aircraft Establishment, but it is not now proposed to give any detailed summary of investigations completed. The experiments have ranged over the whole field of practical aeronautics, including tests relating to airplanes, air-ships, kite balloons, propellers, radiators, wind screens for aircraft, airplane carrying ships, bomb dropping, pressure distribution, stability, etc. A considerable number of experiments have been made on models of complete airplanes, and the work done for the Scale Effect Sub-Committee included an analysis of the resistance of a complete model and comparison of the whole resistance with the sum of the resistances of the component parts. The investigations relating to propellers have been of special value and importance. The question of flight at high altitudes has received attention. In existing circumstances it has not been possible to concentrate attention on general aerodynamical theory, but some consideration has necessarily been given to general questions arising in connection with the experimental work, and the study of eddy motion has been advanced.

The Air Ministry has formed a special Committee to investigate certain questions relating to airscrew design. Dr. Stanton, the Superintendent of the Aerodynamics and Engineering Departments at the National Physical Laboratory, is a member of this Committee, and experiments to obtain information desired by the Committee will be carried out at the Laboratory.

Strength of Construction—Continued attention has been given to questions connected with strength of construction. Early in the year a series of calculations was carried out for various enemy machines to investigate the factor of safety allowed in German design. It is of interest to note that the conclusion resulting from these calculations was that neither in performance nor in strength were the German machines equal to the British. Other things remaining the same, an increase in the factor of safety necessarily involves some reduction in performance and maneuvring power, which, not less than strength, are of vital importance for safety in air fighting; it is clear, however, that the strength factor adopted in British design, which has in earlier years been the subject of much careful consideration by the Committee, has been wisely maintained at a high level. Specific questions relating to strength have arisen chiefly in connection with engines, and propellers in relation to engines, and have been dealt with by the Engine Sub-Committee.

Engines—The Engine Sub-Committee has held 29 meetings during the year 1917-18, and has received 131 reports and memoranda on various matters. The work has been of very varied character. The advice of the Committee was invited by the Air Board on several occasions with regard to the engine programme and the selection of engines for future development. In order to arrive at a decision on questions submitted to them the Sub-Committee has visited works and inspected engines under test conditions. Among other matters which have been before them for discussion may be mentioned the methods of engine testing, engine design for high altitudes, the causes of failure of crankshafts and other parts, gearing, methods of cooling, methods of preventing freezing at high altitudes in water-cooled engines, special fuels, etc. Considerable attention has been given to matters connected with magnetos and ignition, and a large amount of experimental work in this direction has been carried out at the National Physical Laboratory and at the Royal Aircraft Establishment. At the latter also numerous investigations have been carried out for the Committee on engines and engine cylinders, which are referred to more particularly in the section of this report which deals with the experimental work done at the establishment. A series of reports giving the results of experimental investigations undertaken for the Sub-Committee has been prepared for confidential issue, as explained.

Light Alloys—The Light Alloys Sub-Committee was formed in February, 1917. Since that date it has held 18 meetings and has received 93 reports and communications. Experimental work has been carried out for the Sub-Committee at the National Physical Laboratory, the Royal Aircraft Establishment, Birmingham University, and Manchester University, as well as by the Aeronautical Inspection Directorate, and at works foundries. The result has been to secure and to disseminate a large amount of valuable information with regard to both cast and wrought aluminum alloys suitable for use in the manufacture of engines and aircraft parts. Experiments have been made with a number of new alloys, and every effort has been made to accumulate systematic data with regard to alloys in common use, as well as to the newer alloys which appear to exhibit valuable characteristics.

The volume of work on light alloys dealt with at the National Physical Laboratory has been very large, and it has been necessary to ask for additional staff to enable it to be continued and extended in the future. The tests usually made of a new alloy include the tensile strength at ordinary and at high temperatures, the casting properties, contraction, etc., conductivity, co-efficient of expansion, while impact, hardness, and repeated stress tests at various temperatures have been made on many of the alloys. At the Royal Aircraft Establishment engine cylinders and pistons have been cast in special alloys and have been run under working conditions. Professor Lea, of Birmingham University, has worked throughout in the closest possible co-operation with the aluminum foundries, and has kept the Sub-Committee informed as to the progress made in the introduction of new alloys into practice. The wrought alloys have been investigated mainly at the National Physical Laboratory, and with these also substantial progress has been made. The Sub-Committee is indebted to Professor Edwards, of Manchester University, for much valuable assistance in the researches relating to casting alloys; and desires also to acknowledge information and help given to it by many firms and individuals.

Fabrics and Dopes—Research in connection with this section of the work has been continued as in previous years. The work done has included tests of special fabrics and dopes, the further investigation of methods of protection of fabrics, especially airship fabrics, the testing of special materials suggested for wing coverings, determinations of hydrogen purity, and the investigation of methods of determining the purity of hydrogen and the permeability of airship fabrics.

Seaplane Research—Research on float models and models of flying boats in the William Froude National Tank has been actively continued. Additional apparatus has been designed and constructed for the extension of the experiments in certain directions. Some experiments in connection with airships have also been undertaken. Two reports on the work carried on in the tank have been received by the Committee during the year.

Special Investigations—A large amount of work has been carried out in the Engineering Department of the National Physical Laboratory, whether in connection with particular researches required by the Committee or Sub-Committees, or in response to special requests received from the Air Ministry. Among investigations of the former class may be mentioned the general research on the transmission of heat from surfaces to fluids in motion over them, experiments on engine cooling and radiators, impact and hardness tests on light alloys at various temperatures, tests of timber, struts, etc. For much of this work special apparatus has been designed and constructed.

Airships and Kite Balloons—A Sub-Committee was appointed in August, 1917, to consider certain matters relating to airships and kite balloons on which the advice of the Committee had been requested by the Director of Air Services, Admiralty. A preliminary report was submitted in the same month giving replies, so far as was possible with the information then available, to specific questions raised. A further report is now in preparation.

The Air Inventions Committee—This Committee was founded by Lord Cowdray in August, 1917. As originally constituted it consisted of six members of the Advisory Committee, with eight others, chosen either for their special scientific experience or for their connection with the Flying or Anti-Aircraft Service. The Chairman is Mr. Horace Darwin, F.R.S. It reports monthly to the Advisory Committee, and important inventions are referred, when considered desirable, to that Committee. On the other hand, it is now under the general supervision of the newly-appointed Chief of the Air Staff, and its meetings are attended, when necessary, by representatives of the G. H. Q. Home Defences and of the Technical Department of the Department of Aircraft Production. The Committee has also been authorized to invite the attendance of aircraft manufacturers (through the Society of British Aircraft Constructors) when this is thought to be desirable.

With this constitution the Committee hopes to be able to keep in close touch with the most recent experience at the front, as well as with all new methods and manufacturing developments, and thus to ascertain the most pressing needs of the moment as regards inventions.

The personnel is completed by a Secretary and Examiners. The work is done largely through Sub-Committees, of which there are five. The number of inventions received since the formation of the Committee is about 4,000; these are placed on receipt in two categories—(A) those requiring further consideration; (B) those which can be rejected at once.

Class A inventions are further considered either by individual members of the Committee or by one of the Sub-Committees. In some cases they are referred for the opinion of other experts, and when thought desirable experiments and trials are carried out before a final decision is made. Funds are at the disposal of the Committee for the development of an invention when considered to be of value.

There is a good deal of inter-communication with the two other Inventions Committees, i.e., the Munitions Inventions Department, and the Board of Invention and Research, and duplication is prevented mainly by overlap of membership and the cordial relationship between the three Committees.

Information regarding the appliances and methods in use in other countries has hitherto been obtained chiefly through the liaison officers, but arrangements are in contemplation for inviting representatives of the Allies to attend meetings of

the Committee when subjects of mutual interest are being discussed.

Accidents Investigation Committee—The Committee has, on a number of occasions, been asked by the Department concerned to undertake investigations in connection with accidents. The information derived from such investigations is often of the very greatest value. Recently an Accidents Department has been formed under the Air Ministry, and a special Committee, of which Lieutenant-Colonel O'Gorman is chairman, has been appointed to advise as to questions arising in relation to accidents, and as to investigations required to ascertain the causes which have led to them, and the measures desirable to provide a remedy.

Other Special Matters—The Committee was requested by the Aeronautical Society in October, 1917, to nominate a representative to serve on the Technical Terms Committee of the Society. The Committee nominated their Secretary, Mr. F. J. Selby, to serve on their behalf. Lieutenant-Colonel O'Gorman is chairman of the Technical Terms Committee, which has now been constituted also a special Committee of the Engineering Standards Committee, in the section dealing with Aircraft Standardization.

In July, 1917, a request was received from Professor G. H. Bryan that the Committee would give him assistance to enable him to obtain such data as he might need in connection with researches on the stability of the airplane on which he was engaged. The Committee were informed that a grant had been made to Professor Bryan by the Department of Scientific and Industrial Research to enable him to devote himself, for a period, to the prosecution of his investigations relating to the stability of the airplane, and they willingly offered to render such assistance as was within their power. It is understood that Professor Bryan has already arrived at results of considerable interest.

The Committee desire to express their thanks to the many firms and individuals who have given them assistance in various ways, by personal attendance at meetings, by the contribution of papers giving valuable information, or by assistance in experimental work. The cases in which such help has been rendered are too numerous to be referred to in detail, but acknowledgment must be made of the cooperation given by Professor Sir James Dewar, at the Royal Institution, in experiments on light alloys at low temperatures. An interesting communication relative to a matter which was under consideration by the Committee was received from Professor A. E. H. Love, of Oxford University.

Experimental Work at the R. A. E.—As in previous years the Committee are much indebted to the staff engaged in experimental work at the Royal Aircraft Establishment for their valuable contributions to the general progress made in aeronautics research. These contributions, which are most fitly characterized, in general, by the term "full scale work" which has been applied to them in the past, cover a very wide field. In addition to experiments on airplanes in flight, which in themselves are of a very extensive and varied character they include a most important and comprehensive series of investigations relative to engines, and engine parts and accessories, a large amount of experimental work on alloys for engine construction, including foundry work and the manufacture and testing of numerous trial cylinders and pistons in various alloys, as well as of complete engines, investigations relative to fabrics and dopes, the study of instruments of all kinds for use on airplanes, and many other matters.

The measurements on airplanes in flight are an important and essential complement of the model experiments, and have led to many valuable and interesting results. The coordination of the full scale and model work effected by the "Scale" and Aerodynamics Sub-Committees has been of definite advantage in controlling the conclusions to be drawn from the two classes of experiments, and the special investigations called for by these Sub-Committees, while entailing a large amount of experimental work, have left the ground clear for more rapid progress in the future. A considerable part of the full scale work at the Royal Aircraft Establishment on airplanes in flight during the past year has been done for these Sub-Committees in confirmation and amplification of the observations on models. In addition to calculations based on determinations of "performance," and on force measurements, much work has been done on the measurement of actual loading and its distribution on wings in flight, and some remarkable results have been obtained. Among other matters to which much attention has been given may be mentioned the careful study of the conditions which accompany "spinning," and the investigation of controllability, including the design of the necessary instruments for making the observations in flight required for this work.

A large number of investigations in relation to engines have been carried out at the request of the Engine Sub-Committee. These include the design and construction of plant for testing engines under high altitude conditions, the investigation in actual flight of the variation of engine power with height, the continuation of experiments on air cooled cylinders and engines, as well as researches relative to engine temperatures, methods of cooling, magnetos and other accessories, and a number of other problems. In close connection with this work, a large amount of research has also been carried out for the Light Alloys Sub-Committee, including the study of special alloys, the casting of cylinders and other engine parts, in alloys of different composition, and the examination of their behavior under running conditions. Important conclusions have been reached from the comparison of cylinders of different materials.

Investigations have been made on various substitutes for materials difficult to obtain in the quantities necessary for the largely increased production of dope. As a result of this work it has been possible to reduce considerably the quantity of doping material required.

Improvements on the standard airplane instruments have been made, and the methods of testing them with rapidity and accuracy have been advanced. Instruments have been constructed for the full scale measurements, and the work on bomb sights has been continued.

Meteorological Work—A considerable number of meteorological inquiries have been answered and a number of papers relating to meteorological problems have been presented to the Committee. A comparison of the observations of wind velocities in the upper air by means of pilot balloons with those obtained by other methods has given satisfactory results.

The special experimental work in meteorology carried out for the Committee at the Branch Meteorological Office at South Farnborough has been mainly concerned with the methods for noting and recording lightning.

The experimental work has included the design and construction of the apparatus necessary for the equipment of two other stations to act with South Farnborough. Plans have been prepared for the erection of the necessary apparatus, but progress is arrested for the time being for want of assistants who have been or can be trained in the special work. The provisional trials made with the stations available elsewhere have shown that an effective answer to the inquiry is quite within the capacity of the instruments at three properly equipped stations in suitable positions.

Interesting results have been obtained in connection with the study of eddy motion, with an anemometer of special design exposed on a tall chimney, and a contribution has been made to the difficult subject of the variation of wind velocity near the ground.

Book Review

KNIGHTS OF THE AIR. By Lieut. Bennet A. Molter. (D. Appleton & Co. $1.50. 244 pp., 8 full-page ill.)

Lieutenant Molter's book will prove of particular interest to those who have followed with pride and admiration the exploits of that gallant band of Americans who volunteered their services to France at the time when the United States was still neutral; at least officially so.

Besides giving many personal glimpses of the most notable members of the Lafayette Escadrille, the author describes at length the difference between the French and British systems of training airmen and the organization of general routine work at the front. Interesting information is also furnished of the practice of gun-spotting, such as the location of an object on a chart by means of the clock system, and of the dangerous work of placing spies by airplanes behind the enemy lines. Many unusual exploits of well-known airmen are also recalled. The book is well worth reading.

New Duesenberg Engine Test House

The new test house of the Duesenberg Motors Corp. at Elizabeth, N. J., has just been completed. As can be seen in the accompanying illustrations, it is a permanent institution designed with a view to affording facilities for the accurate and expeditious testing of a production run of engines. The building, 240 ft. x 67 ft., is of substantial steel, faced brick and concrete construction, with monitor roof, and is well lighted and ventilated.

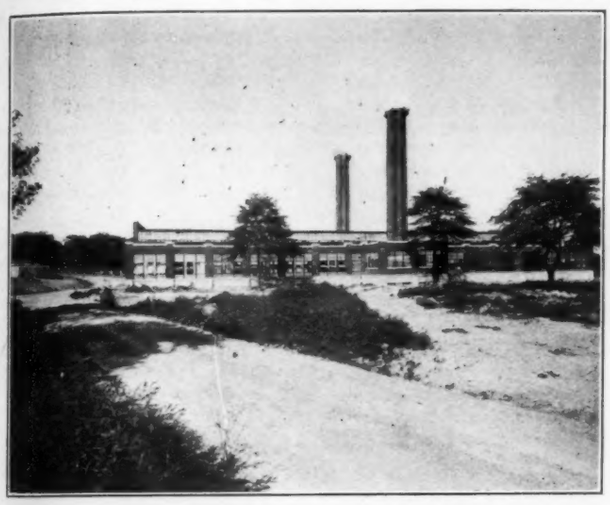
The main test room occupies the center of the building and is 176 ft. long and the entire width. There are facilities for testing twenty-two airplane engines at one time. For testing the production run of engines, torque stands are used, each stand being arranged with its own gasoline, oil, and water tanks. The gasoline tanks are connected up to the main supply and are filled at will by electric-driven pumps. The tanks themselves are set up on scales in order that exact fuel consumption by weight may readily be obtained. The feed to the engine is by gravity. The oil tanks are equipped with calibrated sight gauges. While each test stand has its own water tank, the series of tanks for all the stands are connected up in a circulating system operated by an electric drive water pump which drives the excessively hot overflow water from each motor through a gigantic concrete cooling fountain having a diameter of fifty feet and a cooling capacity of 75,000 gallons.

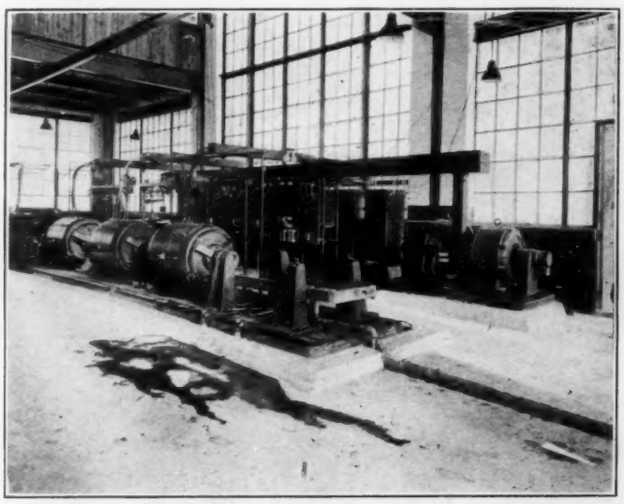
An interesting feature is the method of disposing of the exhaust gases from the running engines. The exhaust from each is directed into main ducts beneath the floor which lead into one or the other of the two eighty-five foot stacks shown in the pictures and the gases are carried out by the natural draft of these chimneys, which also serve to muffle the noise.

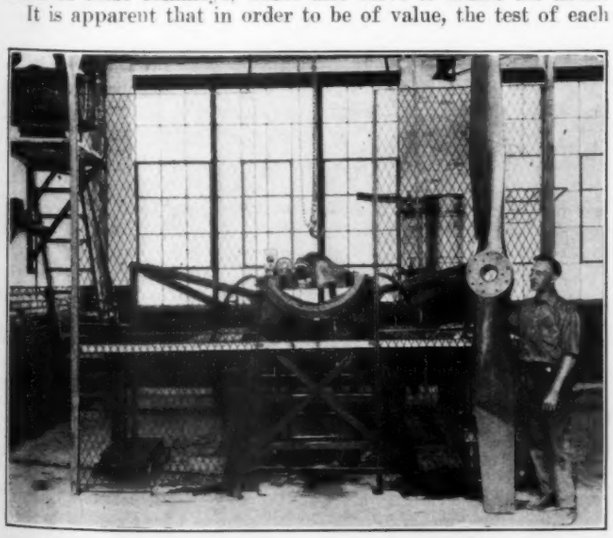
It is apparent that in order to be of value, the test of each engine must be accurately recorded. For this purpose the most accurate equipment obtainable has been installed. Water and oil temperatures are automatically recorded on entering and leaving the engine by delicate recording thermometers. Electric tachometers of the most improved type are installed at each test stand and corrected and calibrated in their permanent locations. Vacuum motors, registering gasoline pumps, oil filters, and many other special devices form the testing equipment.

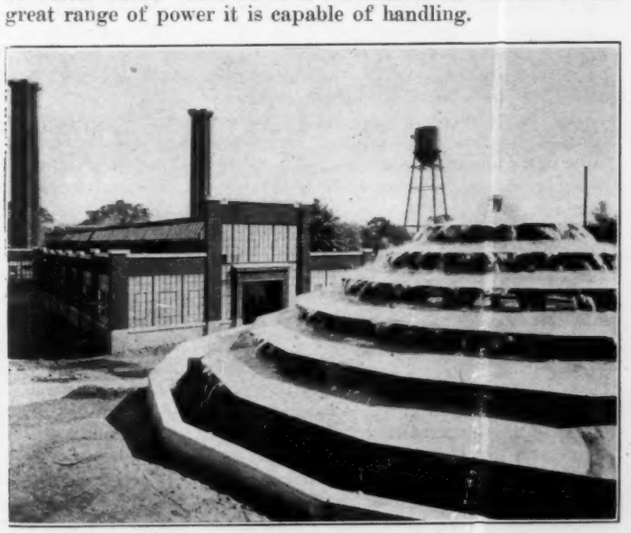
Beyond the main test room is the dynamometer testing room where the actual horsepower tests are run. Clubs for use on the production run of engines are calibrated on a sample motor hooked up to the dynamometer brakes and, of course, all experimental power tests are run on the dynamometers.

The equipment of the dynamometer room consists of three 300-400 hp. Sprague machines with maximum speed of 3500 r.p.m. These machines are set up in concrete in a tandem arrangement and for motors requiring the maximum dynamometer brake are all coupled together, otherwise two or a single machine being used according to the size of the engine to be tested. The switchboard for this outfit is conveniently installed and as these dynamometers are not running continuously enough to make practical use of the current they generate, which is more than enough to operate and light the whole factory, resistance grids have been installed behind the switchboard which are capable of absorbing up to 1200 hp. The engine test stands are set up at either end of the row of dynamometers and the engines are started by the dynamometers acting as motors, the power being commercial A.C. current transformed to D. C. by means of an independent converter outfit. This outfit is remarkable on account of the great range of power it is capable of handling.





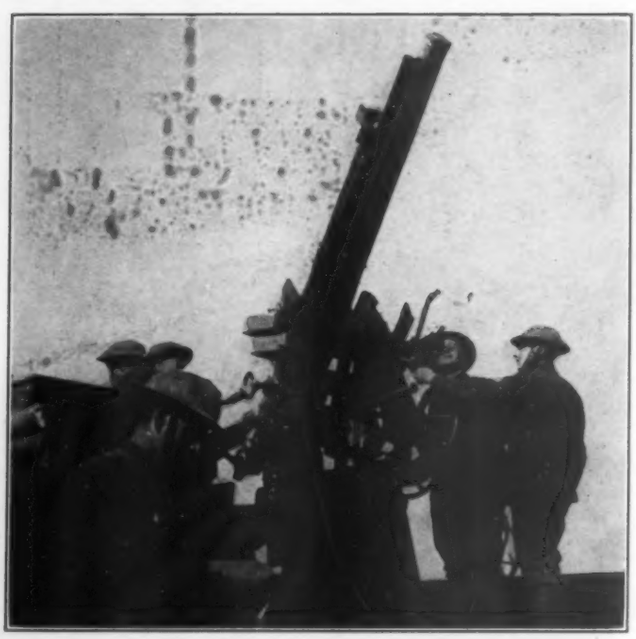




Digest of the Foreign Aeronautical Press

Flying (London), August 21, 1918

Problems in Design and Construction. By Sidney Camm—The paramount problem of the airplane is essentially a question of increasing efficiency, and this to a certain extent means increasing the speed range to much greater limits than are at present possible. The question of any great increase in the speed range of machines must depend on the production of a machine in which it is possible during flight to (1) vary the wing area, or (2) vary the camber, or (3) change the angle of incidence of the planes.



BRITISH ANTI-AIRCRAFT GUN

British Official *Western Newspaper Union*

It will be apparent that any mechanism for varying the wing area during flight is, with present methods of construction, out of the range of practical possibility. Much better chances exist for the production of a variable camber device, and, indeed, glancing back over some few years, one finds a not inconsiderable amount of thought directed to this system.

A favorite device is to construct the wing so that the trailing portion is hinged to the main portion, and arranged to be adjusted from the pilot's seat, being really nothing more than an extension of the ailerons to the total span of the plane. Unfortunately, to be of real use, this improvement would require to be of considerable moment, as otherwise what might be gained in the way of variable speed would be more than offset by the additional weight incurred.

The third method enumerated although possibly the least efficient method of obtaining variable speed, offers considerably more chance of success. The French Paul Schmitt variable incidence biplane was built on this principle. This machine put up several notable records for altitude passenger carrying with an engine of quite moderate horsepower. Mechanical difficulties in the way of the construction of a variable-angle machine although formidable, are certainly not insurmountable. The various adjustable tail systems in use may be considered as realizing to a limited degree the advantages of variable incidence.

Another source from which increased efficiency may be gained for reasons which, in the main, are analogous to the principles of the variable incidence device for the planes, exists in the production of a successful variable pitch airscrew. A machine possessing an airscrew which could be adjuted in pitch by the pilot during flight, would possess a better rate of climb than a machine of the same horsepower with the ordinary type of airscrew by reason of the fact that when climbing, the tendency of the engine to lose revolutions and consequently horsepower would be obviated by the ability of the pilot to adjust the pitch to that best suited for climbing. Further, the loss of revolutions and speed occasioned by flying at high altitudes could be appreciably diminished; one could, in fact, vary the speed of the machine by adjustments in the pitch of the screw, instead of the manipulation of the throttle.

Very little appears to have been accomplished in this direction, and it is probable that designers have hesitated to incorporate complication in a component which, of the various parts of the complete machine, is probably the most severely stressed. The difficulties are as much aero-dynamical as constructional, and it seems fairly evident that, assuming the production of a successful pivoting mechanism, it will be necessary to evolve new blade sections which will give maximum efficiency at various angles. The construction of such a screw calls for the highest workmanship and reliable materials, and, moreover, would probably entail some considerable expense in manufacture.

It is notable that at least one attempt has been made at the commercial production of a variable-pitch screw, this being exhibited by the Integral Co., at the 1914 London Aero Show. This was chiefly intended for airship use, and consisted of two wooden blades very strongly mounted in a metal boss. The mechanism for effecting the alterations in angle was of a particularly practical nature, and of very neat design, but very little appears to have been done to adopt the main features to an airplane screw.

Flying (London), Sept. 11, 1918

On the Value of Parachute. By T. W. Scott.—The only case that can be brought against the parachute as a fitting for every airplane is that it cannot be effieacious in all cases. A machine may catch fire with such suddenness as to destroy the parachute releasing gear, or the fall may occur in such a way that the pilot cannot release himself in time. But to damn the parachute on such grounds is akin to saying that a ship ought not to be fitted with an anchor, because there may be pieces of the sea bed in which an anchor will not hold. It has been proved possible to fit a parachute in such a way that it will simply lift the aviator out of a falling machine, so that, if the machine is in flames, it will fall away from the man held up by the parachute—for one of the objections urged was that, even if a man got away from his machine safely during its fall, the machine might and probably would overtake him on the way down and destroy him.

The common-sense view is that if the fitting of a parachute for every occupant of every airplane on service would save one life in the course of a thousand accidents, then it is imperative that parachutes should be made a standard fitting at once. As a matter of fact, it appears that the standardizing of such a fitting would probably ensure safety in about 50 per cent of the crashes, though, of course, only actual experience could determine the percentage of lives saved. But one in a thousand would make the trial worth while, for one life is worth more than all the parachutes would cost.

Anyhow, the value of the thing is fairly evident from the fact that it has been adopted on German airplanes. It may be urged that it is not good form to copy from the enemy, but in a case of this kind, where a saving of man-power is involved, it is quite safe to copy from the enemy.

The Aeroplane, July 17, 1918

A Rumor Worth Watching.—According to a neutral correspondent of *The Aeroplane* it is rumored that a new type of German airplane which embodies some very unusual features has made its trial flight at the Johannistal aerodrome. The available information has it that the machine is entirely built of duraluminum, without interplane struts, by the Fokker-Junker aero works, and is fitted with an A. E. G. aero-turbine. It is said the machine has a maximum speed of 255 km.p.h., a climb of 15,000 ft. in 11½ minutes, and a maximum endurance of 50 hours.

That there may be some foundation to this rumor seems to be borne out by the fact that the Fokker-Junker works advertised for the last six months for skilled labor to carry out metal airplane work, while on the other hand German interest in the development of an aero-turbine has long been commented upon.

News of the Fortnight

New Control Board Created

Several important changes affecting the organization of the Control Board and the personnel of the Division of Military Aeronautics, Air Service, which had been pending for a number of days and which were known generally in an unofficial way, went into effect on Sept. 30, when at the direction of Major-Gen. W. L. Kenly, Director of Military Aeronautics, a memorandum was made by Lieut.-Col. G. H. Shields, acting as executive in the absence of Col. F. R. Kenney, in which the former Control Board was dissolved and another Control Board, differently constituted, was created. This memorandum, in full, reads:

"1. The Control Board of the Division of Military Aeronautics as now organized is dissolved. There is hereby created a Control Board which shall consist of the Assistant Director, Division of Military Aeronautics, the Chief of the Executive Section, Chief of the Training Section, Chief of the Supply Section, Chief of Operations Section, Chief of Personnel Section, Chief of Medical Section, and an officer to be designated by the Director of the Division of Military Aeronautics.

"2. The functions of the Control Board as hereby constituted shall remain as heretofore established.

"3. The officer designated as a member of the Board by the Director shall be charged with the duty of directing studies and investigations of subjects referred to the Control Board by proper authority; of reporting results of such studies and investigations, with his recommendations thereon, to other members of the Board; of transmitting recommendations approved by the majority of the Control Board to the Director.

"4. All instructions heretofore issued by this office in conflict with the above are rescinded."

The members of the old Board were Col. W. E. Gillmore, President, who last month was detailed to the command of Kelly Field; Lieut.-Col. J. R. White, Major R. P. Cousins and Major (now Lieut.-Col.) B. F. Castle. Of this group, none is a member of the new Board except Lieutenant-Colonel Castle, who by another memorandum under the same date is designated to it, and who has been acting as president since the detachment of Colonel Gillmore.

In the same memorandum, Capt. Robert Bowser and First Lieut. W. F. Vieh are detailed to the new Board. Captain Bowser, who was secretary of the old organization, will, it is understood, continue in the same capacity. Lieutenant Vieh will act as the statistician.

On the same date Col. Gerald C. Brant was designated as assistant to the Director of Military Aeronautics. Colonel Brant succeeds Col. H. H. Arnold as Assistant Director, and had been acting as such for some time before the official announcement of his promotion was made. Since the latter part of last July he had been Chief of the Operations Section in succession to Col. L. C. Brown, and has been succeeded in turn as Chief of Operations by Lieut-Col. Thomas Duncan. Lieutenant-Colonel Duncan was formerly commanding officer of Wilbur Wright Field at Fairfield, Ohio.

Therefore, the reorganized Board will consist of eight members, and barring further changes in personnel, will be composed of the following named officers and chiefs of all the Sections of the Division of Military Aeronautics, except the Chief of the Technical Section, which was recently moved to Dayton, Ohio: Colonels Gerald C. Brant, F. R. Kenney, M. F. Davis, Clinton G. Edgar and Arthur Woods; Lieut.-Cols. B. F. Castle and Thomas Duncan and Brig.-Gen. T. C. Lyster.

Col. Henry C. Pratt has been detached from Brooks Field and assigned to duty in the Executive Section.

Executive Nominations for Promotion

In a list of nominations for promotion sent to the Senate by the President on Oct. 3 are the names of Cols. Brice P. Disque and William Mitchell, both of whom are named to be brigadier-general with rank from Oct. 1, 1918.

Brigadier-General Disque is attached to the Bureau of Aircraft Production and is actively identified with airplane spruce production in the Northwest, while Brigadier-General Mitchell is attached to the Air Service, A. E. F.

At the same time, Brig.-Gen. Peter C. Harris was nominated to be the adjutant-general of the Army with the rank of major-general for a period of four years from Sept. 1 last.

National Advisory Committee Meeting

At the Annual Meeting of the National Advisory Committee for Aeronautics, held at Fourth Street and Missouri Avenue, Washington, D. C., on Oct. 10, reports of progress in the scientific study of the problems of flight were submitted by the Executive Committee and ordered published in the Fourth Annual Report, which will be submitted to Congress in December. The Committee reviewed the present state of the art and adopted estimates for continuing further experimental and research work for the following fiscal year.

In the absence of the Chairman, Dr. W. F. Durand, who is at present in Paris, Dr. John R. Freeman of Providence, R. I., presided. The officers of the Committee and members of the Executive Committee were elected and appointed to serve for one year as follows: Chairman, Dr. John R. Freeman; Secretary, Dr. S. W. Stratton; Members of the Executive Committee: Dr. S. W. Stratton, Dr. J. S. Ames, Dr. J. R. Freeman, Dr. J. F. Hayford, Major Gen. W. L. Kenly, U. S. A., Prof. C. F. Marvin, Dr. W. C. Sabine, Rear Adm. D. W. Taylor, U. S. N., Lieut. Comdr. J. H. Towers, U. S. N., and Dr. C. D. Walcott.

Immediately following the meeting of the full Committee, the Executive Committee met and elected Dr. C. D. Walcott Chairman of the Executive Committee and Dr. S. W. Stratton Secretary of the Executive Committee.

Balloon Corps to Be Increased

Owing to the increased demand from the American Expeditionary Forces for balloon crews, the Balloon Corps of the U. S. Army is to be increased 25,000 men and 1200 officers. It now numbers approximately 11,000, all ranks. Authority has been obtained by the Air Service from the General Staff to induct men of draft age and to transfer officers from the other branches of the service. This increase will create many vacancies in the grades of colonel, lieutenant colonel, major, captain and lieutenant.

Enlisted men and civilians who apply for officers' examinations will be required to take the cadet course of from three to five months, and training camps for this purpose will be conducted this winter in the South and on the Pacific Coast. The schools already established for this purpose are located at Old Point Comfort, Va.; San Antonio, Texas, and Arcadia, Cal.

In addition to the important role played by the balloon in the control of artillery fire, it is now being used with infantry, a caterpillar mount for the winch by which the balloon is controlled, having been successfully used on the front. This portable winch makes it possible for balloon companies to keep up with infantry advances for observation and direction of attack.

In addition to the opportunities for immediate promotion, officers who join the balloon service will receive the benefit of flying pay when they actually do the work of observers.

Inspectors Must Make First Trips

To reduce the fatalities which have resulted from defective workmanship in airplanes and airplane engines, Government inspectors will be required in the future to make the initial trips in the machines they have passed.

This drastic order, in effect, will make the life of the inspector the penalty if a fatal accident results because of his carelessness or incompetence.

The viewpoint of the officials of the Air Service is that if an inspector passed a machine as all right or a mechanician repairs a machine, he should be willing to vindicate his judgment of his skill.

Commenting on this, W. C. Potter, Acting Director of Aircraft Production, said: "It is very desirable that Government inspectors of airplanes and aeronautical engines should have proper appreciation of their responsibility. I know of no better method of impressing upon these men the importance of their work than by giving them a first hand demonstration of the very great stresses and strains put upon airplanes and their engines. In order to accomplish this, arrangements have been made with General Kenly, Director of Military Aeronautics, to issue instructions to officers at testing fields to take inspectors on these flights as fast as the planes are turned out from the factories."

September Aerial Mail Service

Second Assistant Postmaster-General Ottto Praeger issues the following reports of the performance of the Aerial Mail Service during the month of September:

AERIAL MAIL OPERATION FOR SEPTEMBER, 1918.

Date. Sept.	Miles Flown. 1.	Hrs. of Flying. hrs.	min. 2.	Mail Carried. A.	O. 3.	Per Cent. of Performance. 4.	Arrival Wash.	N. Y. 5.
2	436	5	29	27	515	100%	2.44	2.40
3	436	5	30	31½	580	100%	3.15	2.15
4	436	5	39	39½	617	100%	3.10	2.20
5	436	6	11	36	581	100%	4.00	2.08
6	436	5	35	35	608	100%	3.05	2.35
7	436	5	37	35	589	100%	3.18	2.18
9	436	5	51	48½	562	100%	2.47	2.59
10	436	6	03	38½	585	100%	3.05	2.48
11	436	5	50	36	573	100%	2.36	3.04
12	436	5	45	35½	603	100%	3.05	2.27
13	436	5	13	34	559	100%	3.05	2.05
14	436	6	22	34	558	100%	4.00	2.15
16	436	6	11	33½	582	100%	4.05	2.00
17	436	5	26	35	482	100%	3.30	1.50
18	436	7	11	39½	444	100%	7.30	2.50
19	436	6	06	35	608	100%	4.05	1.53
20	436	6	29	33	574	100%	3.50	3.12
21	444	6	04	31	618	100%	5.00	2.30
23	436	5	48	34½	566	100%	3.05	2,44
24	436	6	17	36½	575	100%	3.31	3.30
25	436	6	41	31	361	100%	4.31	2.37
26	654	9	03	34¼	771½	100%	4.10	2.39
27	661	9	25	32½	857½	100%	3.42	2.42
28	436	6	41	34½	589	100%	5.05	1.48
30	436	5	42	34	367	100%	3.08	2.42
Tot'l	11,351	156	00	874¾	14,325			

Note: Number hours of dead flying for the month, 14 hrs. 40 min.

Explanation of Tabulation:

1. *Miles flown:*
   Leg from Washington to Philadelphia..... 128 miles.
   Leg from Philadelphia to New York..... 90 miles.
Miles flown for the day, whether one, two, three or four legs of the trip have been made. The aim is to get exactly the number of miles flown in connection with the mail service each day. Therefore, mileage of partial trips should be indicated.
2. *Hours of flying:* To include the actual hours and minutes machine is in the air with mail.
3. *Mail carried:* In this column, under A., give pounds of airplane mail; and under O., give pounds of ordinary mail.
4. *Per cent. of Performance:* Round trip, Washington-New York, consists of four legs, each leg valued at 25% if completed by airplane and not by train before close of day.

PERFORMANCE OF AVIATORS IN SEPTEMBER.

Total possible number of flights.....	100
Total possible mileage.....	10,900
Total perfect (uninterrupted) flights made.....	97
Total interrupted flights made.....	3
Total flights defaulted on account of weather...	0

Pilot.	Perfect Flights. No.	Miles.	Forced Landings. Interrupted Flights.	Uncompleted Flights.	Total Flights. No.	Miles.
Dana C. DeHart....	32	3488	2 (a)	0	34	3706
Robert F. Shank....	33	3616	1 (b)	0	34	3706
Maurice A. Newton..	30	3270	0	0	30	3270
Max Miller.....	2	218	0	0	2	218
Total.....	97	10,592	3	0	100	10,900

Cause of Forced Landings:
(a) DeHart, September 18, compass disturbances in storm; September 21, ignition trouble.
(b) Shank, September 24, water system trouble.

Test Flight of a De Haviland

Flying from McCook Field, Dayton, Ohio, to Bolling Field, Anacostia, D. C., with no stops, a DeHaviland 9 plane, equipped with a Liberty engine, made the distance from field to field on Oct. 2 in three hours and five minutes. Taking the time of actual flight from a point over the city of Dayton to a point over Washington, the time was two hours and fifty minutes, or at approximately 143 miles an hour. The distance between these two cities is estimated at 430 miles, and it takes the fastest train on the Pennsylvania Railroad from 4.50 in the afternoon to 9 o'clock on the morning of the next day to make this distance. As the speed of this train is a fraction less than 26.6 m.p.h., this airplane flew a fraction of more than sixteen times faster.

Caleb Bragg, a civilian pilot, who flew the plane, is attached to the Engineering Department of the Bureau of Aircraft Production. He carried as passenger an engineering officer. The pilot traveled by compass at a high altitude, and reported that he had no difficulty in holding his course the entire distance. He also stated that the atmosphere was clear and that he had the advantage of a favorable wind.

Mattison Machine Works Move

The Mattison Machine Works of Beloit, Wis., announce the removal of their main offices from Beloit, Wis., to Rockford, Ill.

Men in Essential Industries

Following an announcement last week by Bernard M. Baruch, chairman of the War Industries Board, that there would be cooperation by the War Industries Board and the War Department in determining furloughs from military service of skilled laborers and others engaged in important war work, the War Industries Board has appointed William M. Ritter, of West Virginia, who is assistant to George N. Peek, Commissioner of Finished Products, as Certifying Officer representing the Board in this vital work.

Mr. Ritter will be the point of contact between the War Industries Board and Darragh de Lancy, of the Industrial Furlough Section of the Adjutant General's office in the War Department, through whom decision will be made as to the essentiality of certain men in war industry and necessity for their furlough from military service, although called in the selective draft.

All requests for the furlough of men made by the various departments of the War Industries Board will be made through Mr. Ritter, who will make such investigation in each case as in his judgment the circumstances warrant to determine whether the requests are justified.

Heads of industries in war work who find that the draft is taking from them such of their skilled men as to impair efficiency and seriously reduce production of war material are expected to apply to the War Industries Board for the furlough of these essential skilled men. Commodity Section Chiefs in the Board, handling matters in connection with the industry alleged to be affected by the draft, will make investigations as to the needs and conditions before acting on the requests for furloughs coming to them, and will then report to Mr. Ritter.

Men furloughed from military service on the recommendation of Mr. Ritter as Certifying Officer for the War Industries Board, will be instructed to report to the industry applying for their furlough and that industry will be required to make regular monthly reports to the Certifying Officer showing the continuance of the furloughed men in their employ. Change of place of employment or of character of work will lead to revocation of the furlough order, and return of such men to or into the military service under regulations of the War Department.

$178,758,366 Asked for Aeronautics

Under date of Sept. 16 the War Department submitted to Congress supplemental estimates of appropriation required for the fiscal year ending June 30, 1919. The request is for a total of $7,347,727,602.32, of which $178,758,366.85 is for the use of the Division of Military Aeronautics and $104,180,934 for the office of the Chief Signal Officer.

The other items are: Office of the Chief of Staff, $1,000,000; office of Provost Marshal General, $23,617,302; Quartermaster Corps, $2,014,405,499.29; Medical Department, $293,800,000; Engineer Department $335,000,000, and Ordnance Department, $3,585,874,660.

New Altitude Record

Capt. R. W. Schroeder, A. S., broke on Sept. 18 all previously known altitude records by reaching an altitude of 28,900 ft. Captain Schroeder left Wilbur Wright Field, Dayton, Ohio, in a two-seater Bristol powered with a 300 hp. Hispano-Suiza engine and landed at Canton, Ohio, some miles distant, after being in the air for one hour and forty-five minutes. He was not equipped with an electrically warmed suit, and his lower lip and fingers on both hands were severely frozen. As the day was cloudy and windy, the feat was an especially noteworthy case of extreme nerve and flying ability.

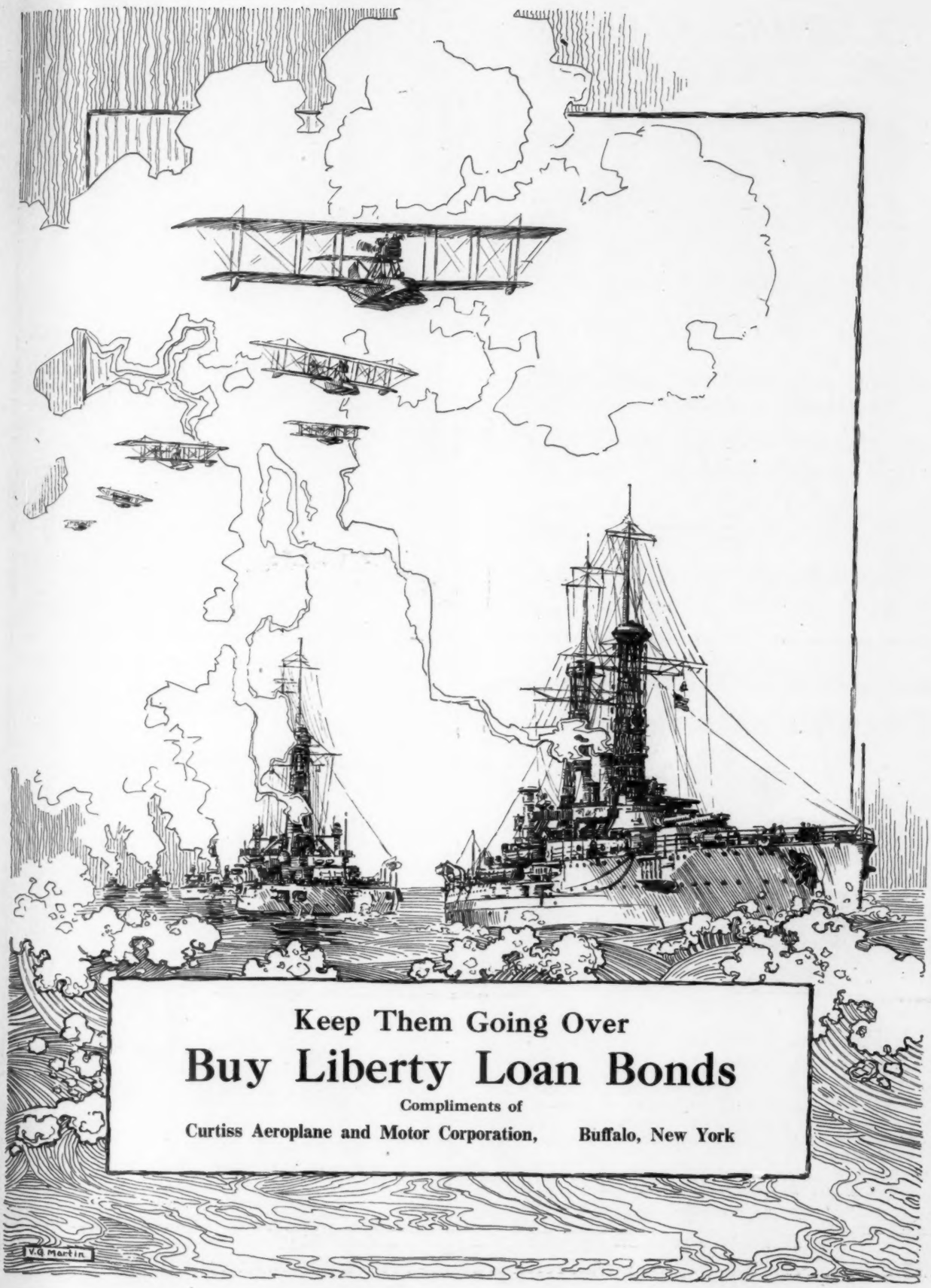
Captain Schroeder and the engine consumed oxygen above 25,000 ft.

Aircraft Workers and the Draft

Benjamin L. Williams has been made Draft Supervisor of the Standard Aircraft Corp. of Elizabeth, N. J., for the purpose of co-operating with the provost marshal general, the local boards and advisory committees in filling their quota of men.

Aircraft manufacturers who want to retain skilled workmen in their employment should obtain from the Director of Aircraft Production, Washington, D. C., these blank forms: War Department—Fri—5, Fri—11, Fri—11A and the application blank Form 1.

These forms were printed in the Aug. 1 issue of AVIATION AND AERONAUTICAL ENGINEERING.



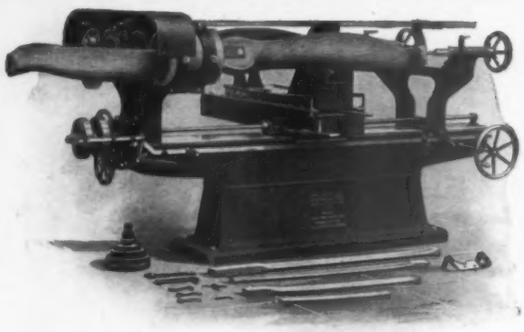
Keep Them Going Over

Buy Liberty Loan Bonds

Compliments of

Curtiss Aeroplane and Motor Corporation, Buffalo, New York

THE DEFIANCE AUTOMATIC AIRPLANE PROPELLER LATHE



IT HAS GOVERNMENT AND MANUFACTURERS' ENDORSEMENTS

The proof of this lies in its use in England, in Italy, in Canada; its use in United States Government Arsenals, and fifteen of the leading propeller factories in America. Each machine in use releases from eight to ten skilled workmen for other duties. With one man operating a number of machines, the cost of working propeller blades close to size is reduced to a minimum. It automatically turns propeller blades of various sizes to any shape or pitch, and it will duplicate struts of irregular shape in facsimiles. Write for our circular which illustrates and describes this machine.

THE DEFIANCE MACHINE WORKS

DEFIANCE, OHIO, U. S. A.

NEW YORK *LONDON*

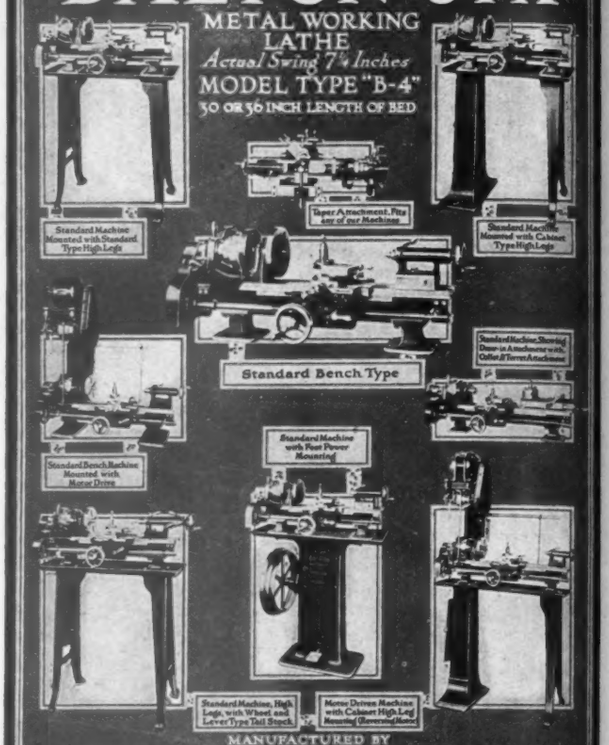
"DALTON SIX"

METAL WORKING LATHE

Actual Swing 7¼ Inches

MODEL TYPE "B-4"

30 OR 36 INCH LENGTH OF BED


Taper Attachment. Fits any of our Machines
Standard Machine Mounted with Standard Type High Legs
Standard Machine Mounted with Cabinet Type High Legs
Standard Bench Type
Standard Machine with Foot Power Mounting
Standard Bench Machine Mounted with Motor Drive
Standard Machine, High Legs, with Wheel and Lever Type Tool Stock
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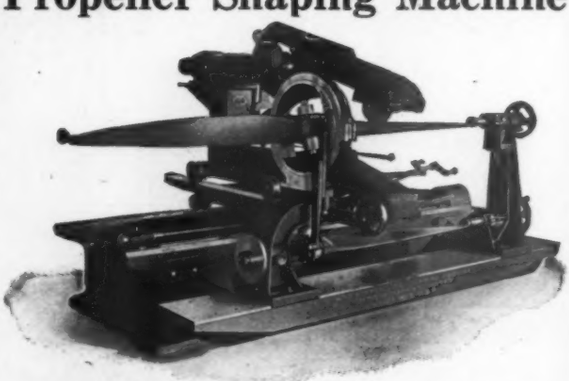
MATTISON

Propeller Shaping Machine



For Two, Three and Four-Bladed Screws

A brand new machine—designed and built with the thoroughness characteristic of all Mattison woodworking machines—which has been approved by many of America's largest propeller manufacturers.

It works close to finish-size, thereby eliminating the greater part of the expensive hand work which usually follows the machining operation of other methods.

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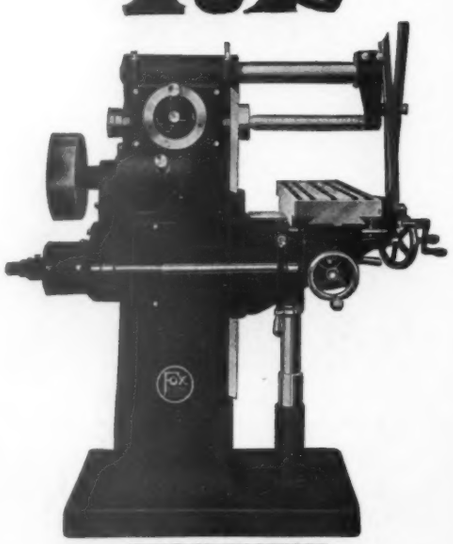

No. 2B PLAIN MILLER

Single Pulley Drive

12 changes to spindle speeds
6 changes to each spindle speed

No. 9 taper in spindle.
Table 8½ x 37"

Hardened machine steel gears throughout insure maximum driving power at all speeds.

We also build Universal Millers, Dividing Heads, Vertical Attachments and Vises.

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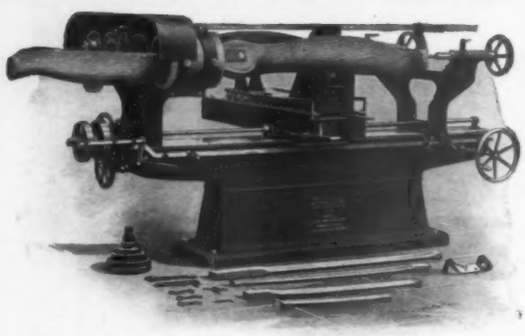

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The proof of this lies in its use in England, in Italy, in Canada; its use in United States Government Arsenals, and fifteen of the leading propeller factories in America. Each machine in use releases from eight to ten skilled workmen for other duties. With one man operating a number of machines, the cost of working propeller blades close to size is reduced to a minimum. It automatically turns propeller blades of various sizes to any shape or pitch, and it will duplicate struts of irregular shape in facsimiles. Write for our circular which illustrates and describes this machine.

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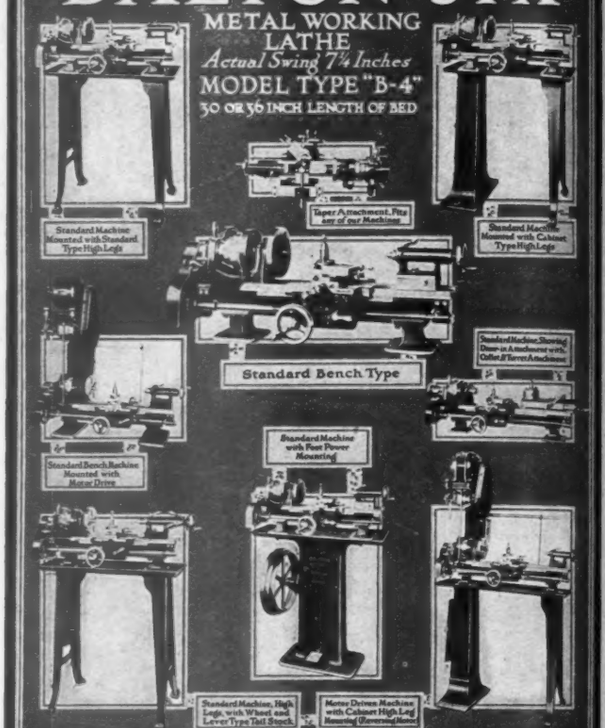

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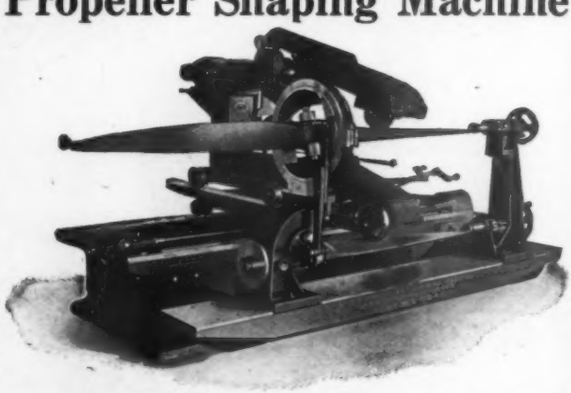
MATTISON

Propeller Shaping Machine



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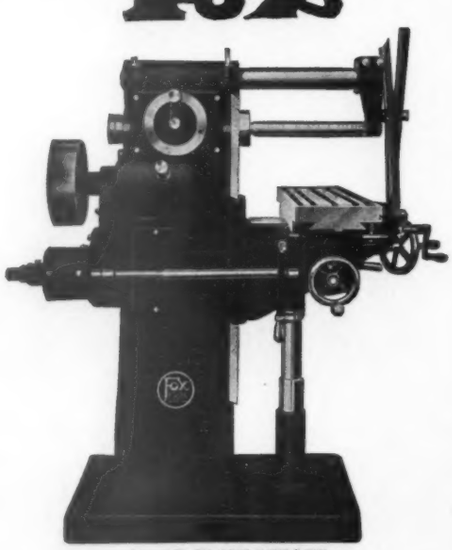

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All Steel Rudders —Elevators— Fins and Stabilizers— Steel Trailing and Leading Edges — Struts and Braces (stream line and oval) Bent Tubing and Metal Fuselage Parts—Special Metal Designs
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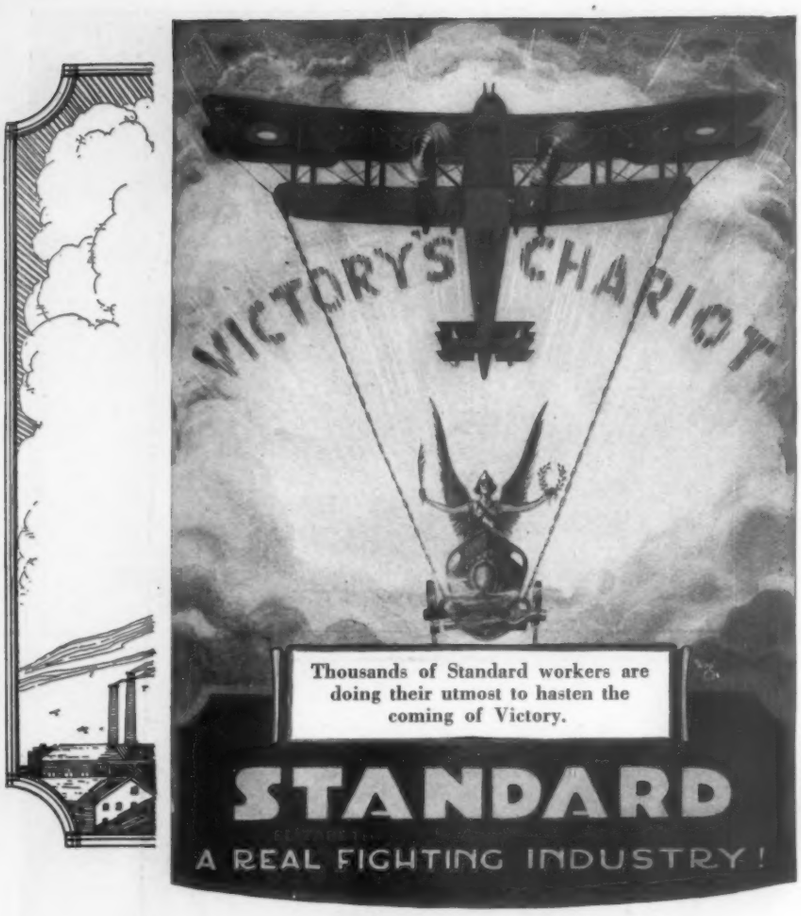
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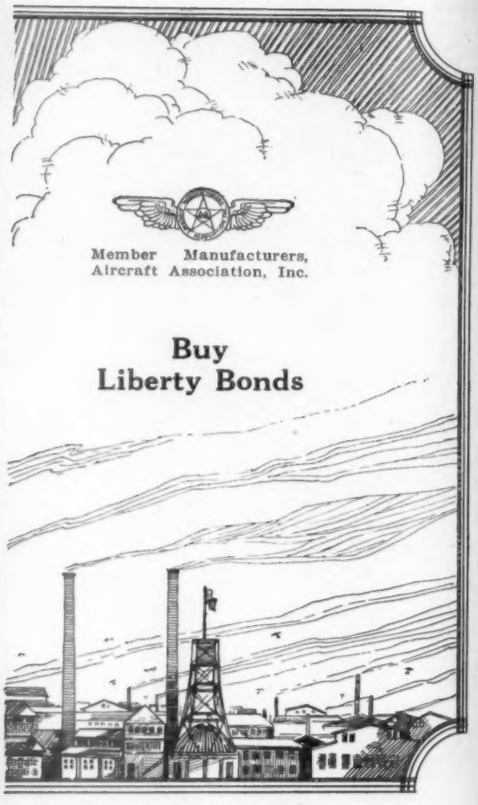
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For Aviation Officers and Mechanics

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NORVAL W. LESLIE, Flight Sub-Lieutenant, R.N., instructor Aviation Department, Dunwoody Institute.

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II. ***Tiemann Humidity Regulated Kilns*** (as designed and developed by the Forest Products Laboratory at Madison, Wisconsin).

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Batteries of combination *Grand Rapids-Tiemann* kilns have just been selected and purchased for the *United States Government* Experimental Department at McCook Field and for the *United States Government* Aircraft Repair plant "Somewhere in France."

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FISHER BODY CORPORATION, 2 orders
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We use Luma exclusively because we believe it to be the world's best luminous material. Luma contains only Radium as its activating agent, no Mesothorium, Radiothorium, Ionium nor Polonium being added.

Our several dial painting factories are fully equipped to handle successfully orders of any size

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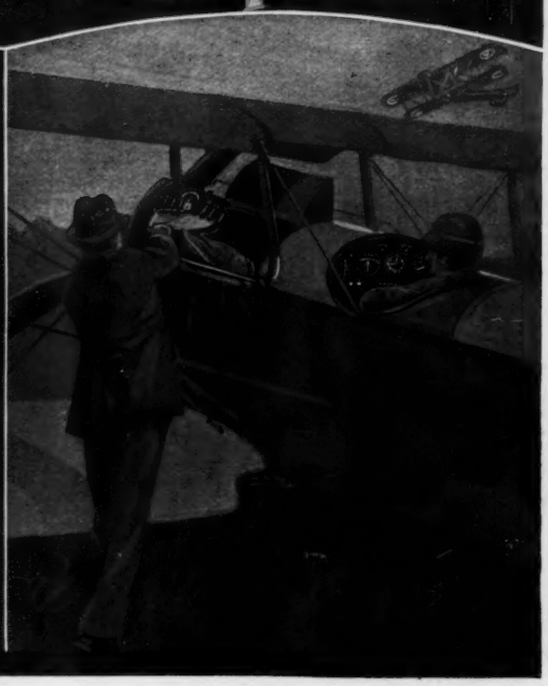

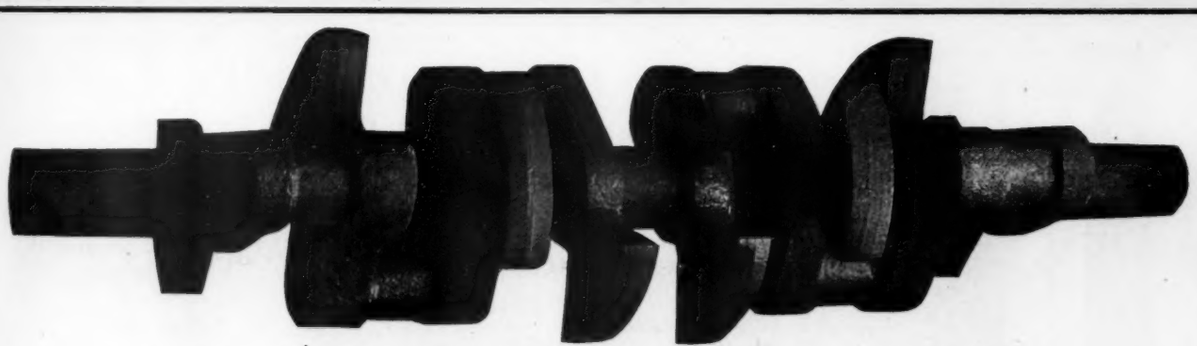

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one of the 18 different
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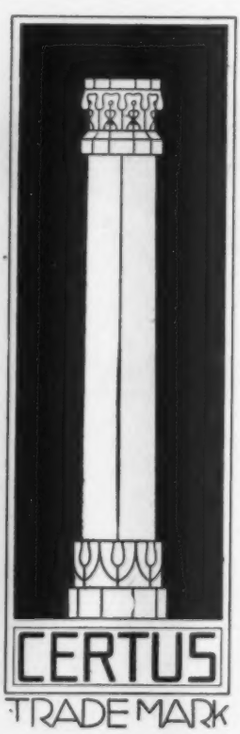

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By CHARLES M. SCHWAB

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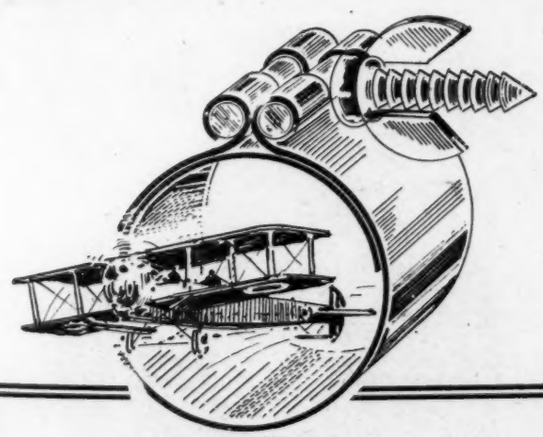

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Now let's all get together and help the boys push the Huns back into the Rhine!

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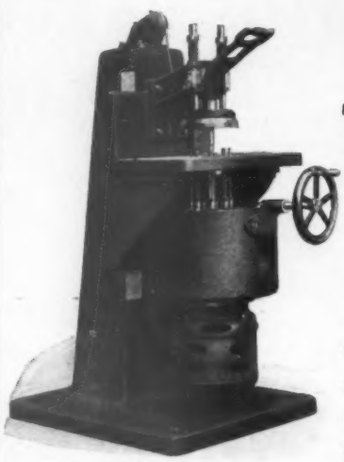

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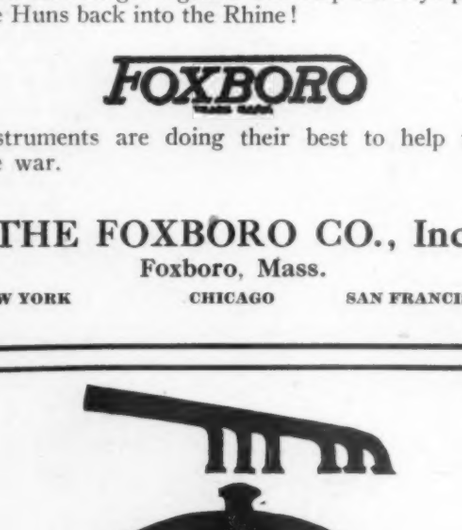

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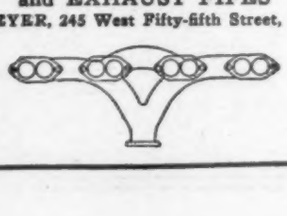

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Names of Advertisers in this issue are printed in capitals.

See Index to Advertisers on page 397

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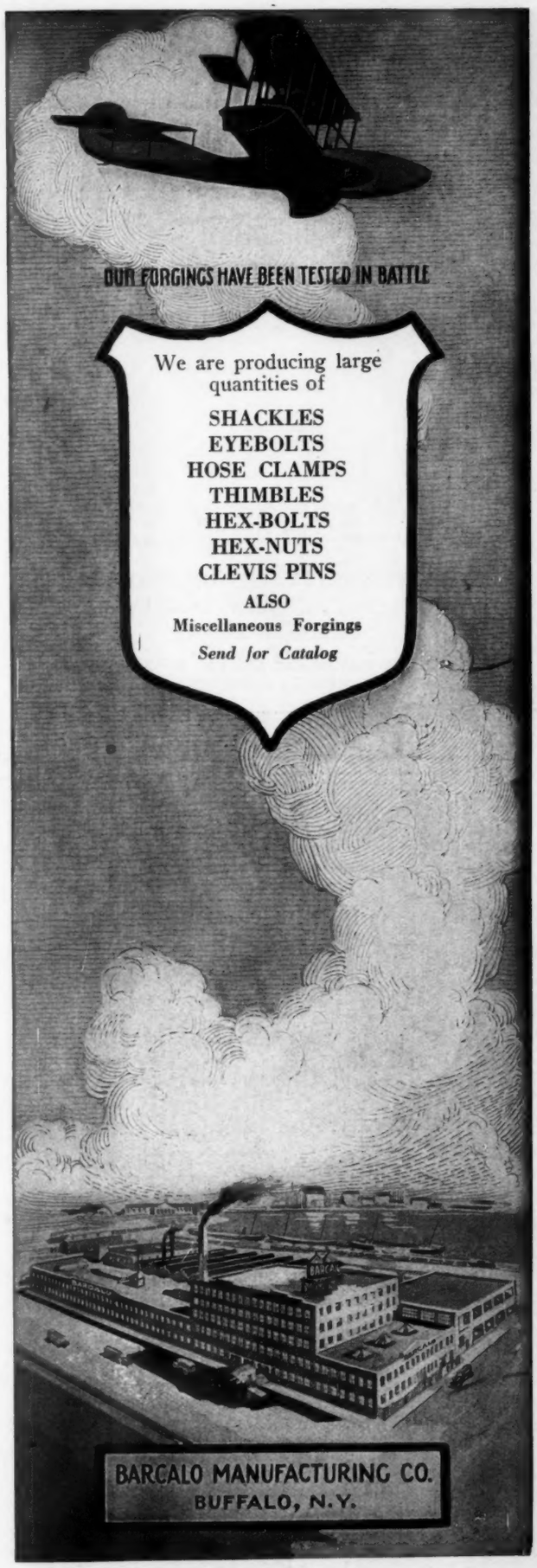

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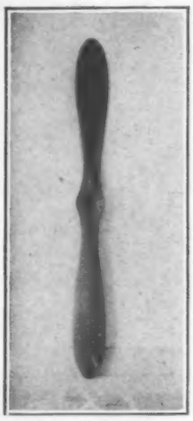

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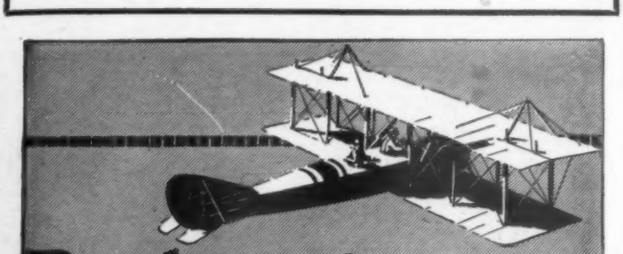
New Haven, Conn., U. S. A.
G&O Radiators



Baker's A-A Castor Oil

Specially Refined for the Lubrication of AERONAUTICAL MOTORS

BAKER CASTOR OIL CO.

Founded 1857

The Oldest and Largest Manufacturers of Castor Oil in the United States

120 BROADWAY - - - NEW YORK

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of AVIATION AND AERONAUTICAL ENGINEERING, published semi-monthly at New York, N. Y., for October 1, 1918.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared H. I. Bowne, who, having been duly sworn according to law, deposes and says that he is the General Manager of AVIATION AND AERONAUTICAL ENGINEERING and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912 embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Gardner-Moffat Company, Inc., 120 West 32nd St., New York N. Y.; Editor, H. M. Williams, 120 West 32nd St., New York, N. Y.; Managing Editor, H. M. Williams, 120 West 32nd St., New York, N. Y.; Business Managers, H. I. Bowne and George Newbold, 120 West 32nd St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

The Gardner-Moffat Company, Inc., 120 West 32nd St., New York, N. Y.; William I. Seaman, Trustee for Lester D. Gardner, 120 West 32nd St., New York, N. Y.; William I. Seaman, 120 West 32nd St., New York, N. Y.; William D. Moffat, 120 West 32nd St., New York, N. Y.; Margaret K. Gardner, 120 West 32nd St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

H. I. BOWNE.

Sworn to and subscribed to before me this twentieth day of September, 1918.

[SEAL.] ELSIE GILMAN.

My commission expires March 30, 1919.

Aeronautical Trade Directory—*Continued*

BALL BEARINGS

The Fafnir Bearing Co.
Gurney Ball Bearing Co.
Hess-Bright Mfg. Co.
NEW DEPARTURE MFG. CO.
NORMA COMPANY OF AMERICA
S. K. F. Ball Bearing Co.
U. S. Ball Bearing Mfg. Co.

BALLOONS: DIRIGIBLES

Burdette Oxygen Co.
Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
Gas Engineering Co. (Gas Plants)
GOODYEAR TIRE AND RUBBER CO.
United States Rubber Co.

BAROGRAPHS AND BAROMETERS

Green, Henry J.
International Aeronautical Instrument Corp.
Sussfield & Lorch
TAYLOR INSTRUMENT COMPANIES

BEARING METALS

Aluminum Castings Co.
AMERICAN BRONZE CORP.
FAHRIG METAL CO.
General Aluminum & Brass Mfg. Co.
Levett, Walker M., Co.
Magnolia Metal Co.

BUSHINGS

Aluminum Castings Co.
AMERICAN BRONZE CORP.
Bound Brook Oil-less Bearing Co.

CARBURETORS

H. & N. Mfg. Co.
Master Carburetor Co.
Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler & Schebler
ZENITH CARBURETOR CO.

CLOCKS AND WATCHES

Chelsea Clock Co.
Depollier, J., & Son
Hamilton Watch Co.
Ingersoll, Robert H., & Bros.
Waltham Watch Co.

CLOTHING

Abercrombie & Fitch
Cross, Mark
N. Y. Sporting Goods Co.
Rainwear Co.
Rogers, Peet & Co.
Sanders Company
Spalding, A. G., & Bros.

COMPASSES

SPERRY GYROSCOPE CO.
Star Compass Co.
TAYLOR INSTRUMENT COMPANIES

DOPE AND VARNISH

Adams & Elting Co.
American Emaillite Co.
BROOKLYN VARNISH MFG. CO.
Certus Cold Glue Co.
Chemical Products Co.
Conover, The C. E., Co.
DU PONT CHEMICAL WORKS
Flexible Compound Co.
Harland, Wm., & Son
Howe Varnish Co.
Lucas, John, Company
Masury, John W., & Son
Perry-Austen Company
PRATT & LAMBERT
Sherwin-Williams Co.
Smith, Edward, & Co.
Standard Varnish Works
VALENTINE & COMPANY
Weeks & Co.

DRIFT INDICATOR

SPERRY GYROSCOPE CO.

DRY KILNS

Cutler Dry Kiln Co.
Drying Systems, Inc.
Grand Rapids Veneer Works

DYNAMOMETER

Sprague Electric Works

ENGINE PARTS

Allegheny Forging Co.
Aluminum Castings Co.
Anderson Forge & Machine Co.
BARCALO MFG. CO.
Brooks Machine Co.
Burd High Compression Ring Co.
Crosby Steam Gage & Valve Co.
Dallet, Thos. H., Co.
DOEHLER DIE CASTING CO.
ERIE SPECIALTY CO.
Fibre Finishing Co.
General Aluminum & Brass Mfg. Co.
Gifford, Leland, Co.
Gill, P. H., & Sons
Hayes Mfg. Co.
Hydraulic Pressed Steel Co.
Levett, Walker M., Co.
Meisel Press Mfg. Co.
PARK DROP FORGE CO.
Pressed & Welded Steel Products Co.
Standard Parts Co.
STIMPSON, EDWIN B., CO.
Taft-Peirce Mfg. Co.
Tioga Steel & Iron Co.
Williams, J. H., & Co.
Whitman & Barnes Mfg. Co.
WYMAN-GORDON CO.

ENGINEERING

AUTOMOTIVE ENGINEERING CO.
Ordnance Engineering Co.
White, J. G., Engineering Corp.

FABRICS

Courtrai Mfg. Co.
Hutchinson, Scott Co.
Lamb, Finlay & Co.
McBratney, Robt., & Co.
Whitman, Clarence & Co.

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Booth Felt Co.
Western Felt Works

FIRE EXTINGUISHERS

Fyr-Fyter Co.
JOHNS-MANVILLE, H. W., Co.
Pyrene Mfg. Co.

GAGES

Advance Felt Specialty & Cutting Co.
BOSTON AUTO GAUGE CO.
Crosby Steam Gauge & Valve Co.
FOXBORO CO., INC.
Greenfield Tap & Die Corp.
United States Gage Co.

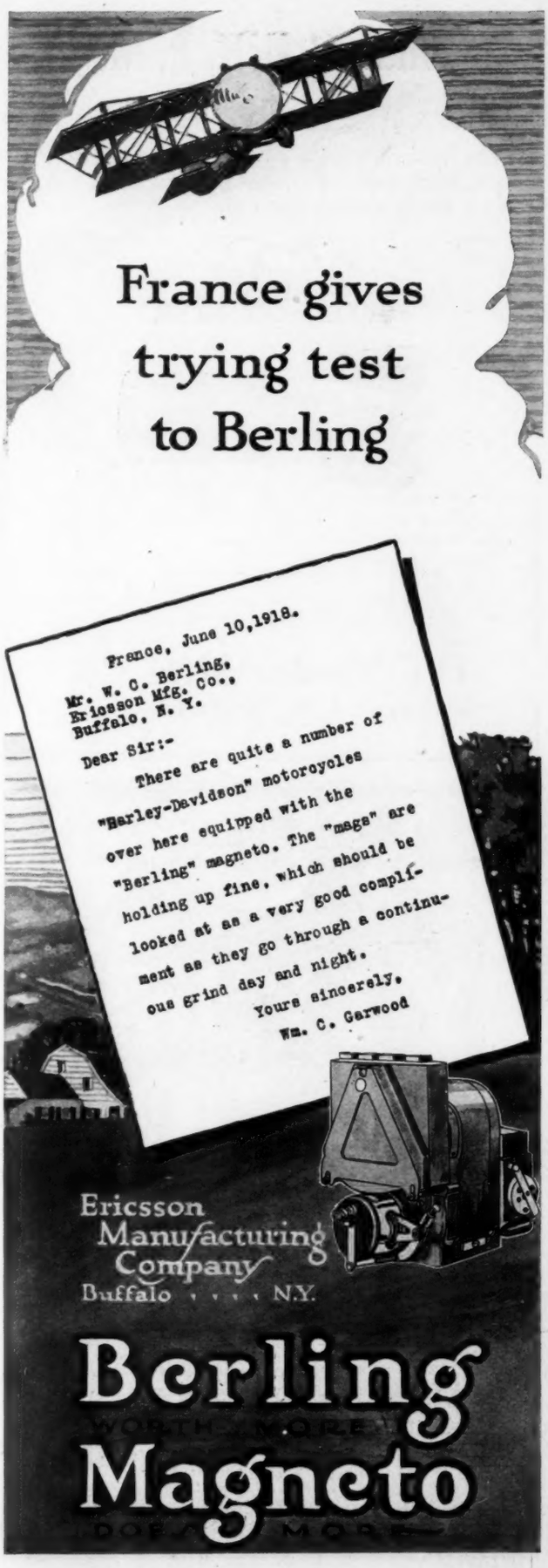
GASKETS

Advance Felt Specialty & Cutting Co.
Booth Felt Co.
Fibre Finishing Co.

GLUE

Armour Glue Works
Baeder & Adamson
Certus Cold Glue Co.
Ferdinand, L. W., & Co.
WIDMAN, J. C., CO.

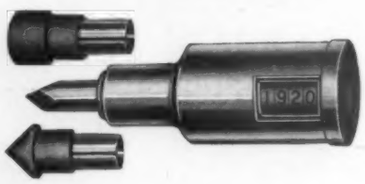
(*Continued on page 389*)


France gives trying test to Berling
France, June 10,1918.
Mr. W. C. Berling,
Ericsson Mfg. Co.,
Buffalo, N. Y.
Dear Sir:-
There are quite a number of "Harley-Davidson" motorcycles over here equipped with the "Berling" magneto. The "mags" are holding up fine, which should be looked at as a very good compliment as they go through a continuous grind day and night.
Yours sincerely,
Wm. C. Garwood
Ericsson Manufacturing Company
Buffalo . . . . N.Y.
Berling
Magneto

Finding the R. P. M. of Airplane Motors

You have the opportunity to replace the time and labor waste of the preliminary block test by a handy application of the

Veeder
SPEED COUNTER



Simply hold the Veeder against revolving propeller shaft; apply slight pressure the moment you start timing; release pressure when minute is up. Clutch starts or stops recording mechanism instantly, giving accurate readings without need of stop-watch. Price, $3.00.

Veeder Counters for recording the production of machines are standard for all industrial purposes. Send for booklet.

The Veeder Mfg. Co.
56 Sargeant St., Hartford, Conn.

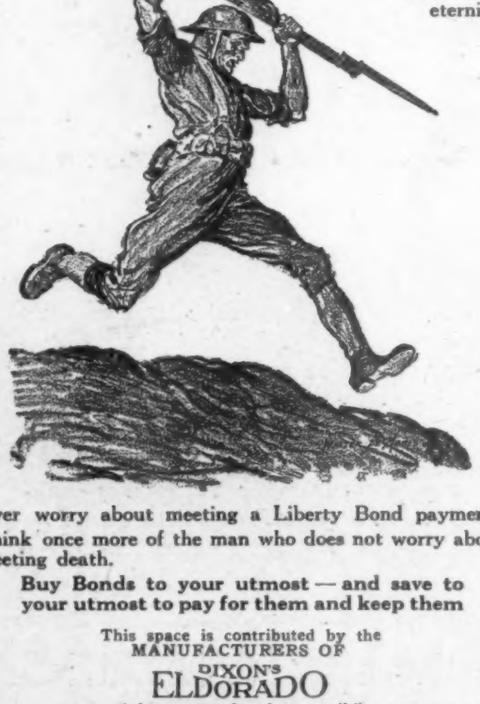
FUEL LEVEL GAGES

This cut shows our Model 51 Gage which is standard on practically all type of military training machines.

Other types of gages in large quantities are "doing their bit" as part of the equipment of English Government Warplanes.

SPECIAL TYPES DESIGNED FOR YOUR ESPECIAL NEEDS.

BOSTON AUTO GAGE CO.
8 WALTHAM STREET, BOSTON, MASS.



THE FIGHTER has no time to count the cost as he jumps into the unknown as he springs to success or eternity.

Ever worry about meeting a Liberty Bond payment? Think once more of the man who does not worry about meeting death.

Buy Bonds to your utmost — and save to your utmost to pay for them and keep them

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Developed from years of experience in building all types of radiators.
They possess every feature and qualification necessary for a high grade product.

STRONG
EFFICIENT
DURABLE

Used on the best American flying machines.
Our engineering department is at your service.

Rome-Turney Radiator Company
Rome, N. Y., U. S. A.

Aeronautical Trade Directory—*Continued*

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Meyrowitz, E. B.
STRAUSS & BUEGELEISEN
Streng, Kennard & Nutt
Triplex Safety Glass Corp.
Willson, T. A., & Co., Inc.

HANGARS

American Bridge Co.
Anchor Corrugating Construction Co.
Ashley Steel Bldg. Co.
Austin Co., The
Barney, John M.
Howell, Field & Goddard, Inc.
Keasby & Mattison
Milliken Brothers
Pruden, The C. D., Co.
Steel Fabricating Co., The
Virginia Bridge & Iron Co.

HOISTS

Yale & Towne Mfg. Co.

IGNITION

Philips-Brinton Co., The

LIFE PRESERVERS

Robinson-Roders Co.
Universal Safety Mattress Co.

LUMBER

Alcock Co., John L.
American Balsa Corp.
Astoria Veneer Mills & Dock Co.
Chetham Lumber Co.
Delatour, J.
Dutton, A. C., Lumber Corp.
Ludlow, Israel
Mengel, C. C., & Bros. Co.
New Jersey Veneer Co.
Sheip & Vandergrift

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Cummings, W. L., Chemical Co.
RADIUM DIAL CO.
RADIUM LUMINOUS MATERIAL CORP.

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DEFIANCE MACHINE WORKS
FOX MACHINE CO.
Warner & Swasey Co.

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DEFIANCE MACHINE WORKS
Fay, J. A., & Egan Co.
FOX MACHINE CO.
Machinery Merchants, Inc.
MATTISON, C., MACHINE WORKS
Olney & Warrin
Pryibil, P., Machine Co.
YATES, P. B., MACHINE CO.

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Berkshire Magneto Corp.
Bosch Magneto Co.
ERICSSON MFG. CO.
Remy Electric Co.
Splitdorf Electrical Co.

MANIFOLDS

AJAX AUTO & AERO SHEET METAL CO.
Pressed & Welded Steel Products Co.

METALS

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American Vanadium Co.
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Betz-Pierce Co., The
BLUM, JULIUS & CO.
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Federal Pressed Steel Co.
Garland Ventilator Co.
Gueder, Paeschke & Frey Co.
KAWNEER MFG. CO.
La Salle Steel Co.
Levett, Walker M., Co.
Rumford Metal Co.
SO-LUMINUM MFG. & ENG. CO.
Standard Alloys Co.
Steel Sales Corp.
Steel Products Co.
STIMPSON, EDWIN B., CO.
Wheeler, Frank H., & Son

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Wading River Mfg. Co.

MOTORCYCLES

Excelsior Motor Mfg. Supply Co.
HENDEE MFG. CO.
Harley-Davidson Co.
Militare Motor Vehicle Co. of America

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BAKER CASTOR OIL CO.
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Gulf Refining Co.
Sheppard Ideal Oil Co.
Sun Co., The
Standard Oil Co.
Swan & Finch
Texas Co., The
Vacuum Oil Co.
Wakefield, C. C., & Co., Ltd.

PACKING

Advance Felt Specialty & Cutting Co.
Booth Felt Co.
Fibre Finishing Co.

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Herbert & Huesgen Co.

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Levett, Walker M., Co.

PISTON RINGS

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PONTOONS

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PALMER-SIMPSON CO.
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C. M. O. Physical Laboratory
Doyle, W. A.
Flottorp Mfg. Co.
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JACUZZI BROS.
Jamestown Propeller Co.
Lang Propeller Co. of America
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Reinforced Propeller & Insulating Co., The
United States Aero Propeller Co.
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WEST WOODWORKING CO.

(*Continued on page* 391)

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(Patent Pending)

Manufacturers of

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Swesco Wing Beams
Waterproof Plywood Panels
Laminated Construction for All Parts

Highest Quality
Quantity Production
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Indian Motocycle
HENDEE MANUFACTURING COMPANY
(*Largest Motorcycle Manufacturers in the World*)
787 STATE STREET SPRINGFIELD, MASSACHUSETTS

"Force, to the Utmost"

That plunging squadron of German Cavalry, expecting to carry all before it in one mad rush, learned to the full, from a little body of American troops, the meaning of the President's words.

Force, greater even than the military rulers of Germany can imagine—the overwhelming, irresistible force of a great, free Nation aroused to fight for its Liberty and the Liberty of the World.

"Force to the Utmost"

Men by the Million! Shot, shell, guns, airplanes, tanks, ships—anything and everything required to drive home the meaning of the President's words to make plain, to the authors of the war, the fact that with such force, of men and of spirit, we must inevitably win.

Are YOU adding every ounce you can to the force behind our fighting men—the force we must exert to win the war?

Lend the Way They Fight — Buy Bonds to Your Utmost

This Space Contributed to Winning the War by
Aluminum Brazing Solder Company, Chester, Pa., U. S. A.

TURNBUCKLES

of the

Highest Quality

to Meet the Most
Exact Requirements

Standard Turnbuckle Company

CORRY, PA.

New York Office: Woolworth Building

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

The Very Stuff of Victory

The materialist has said buying Liberty Bonds signifies nothing.

He looks upon each issue as representing an investment which has no equal today in all the world.

Consequently, he views their purchase as involving no sacrifice nor deserving of credit. As far as his vision lets him see he is right. But unfortunate is he, indeed, who cannot look beyond the simple action and recognize the full power of the motive.

That these bonds are the greatest investment in the world may rightly be laid at the feet of good fortune, because they are *the promise-to-pay-with-interest of the greatest government in the world,* backed by the most tremendous resources in the world.

Such, however, is not the great overwhelming and impelling reason that millions of red-white-and-blue men and women now own billions of dollars of Liberty Bonds and in this Fourth Liberty Loan are subscribing for billions more.

The motive is a far deeper one. It transcends all material considerations and its fabric is the very stuff of victory.

For Liberty Bonds to the great host of American men and women represent work accomplished, thrift acquired, money saved and devoted without stint or limit to that greatest purpose which shall finally achieve victory over organized force inimical to the peace of the world.

So when your dollars are invested in United States Government Bonds of the Fourth Liberty Loan, though they are invested in the *most wonderful investment in the world,* they become more than ordinary dollars because they are then the concrete expression of a hallowed purpose and dedicated to its achievement, the very stuff of victory.

This Space Subscribed to Winning the War by

J. W. Wood Elastic Web Co.
Stoughton, Mass.

Aeronautical Trade Directory—*Continued*

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FOXBORO CO., INC., THE
Moto-Meter Co.
Shore Instrument & Mfg. Co.
TAYLOR INSTRUMENT COMPANIES

RADIATORS
AJAX AUTO & AERO SHEET METAL CO.
A-Z Co.
Bush Mfg. Co.
El Arco Radiators Co.
English & Mersick Co.
FLEXO MFG. CO.
Harrison Radiator Co.
Livingston Radiator Co.
McCord Mfg. Co.
ROME-TURNEY RADIATOR CO.
STANDARD ROLLER BEARING CO.

RIVETS
STIMPSON, EDWIN B., CO.

SCELEROSCOPE
Shore Instrument & Mfg. Co.

SHEET METAL FITTINGS
BLUM, JULIUS & CO.
Rogers Construction Co.

SHOCK ABSORBERS
DURAL RUBBER CORP.
General Rubber Goods Co.
Ohio Rubber Co.
Russell Mfg. Co.
WOOD, J. W., ELASTIC WEB CO.

SPARK PLUGS
Bosch Magneto Co.
Champion Ignition Co.
Johns-Manville, H. W., Co.
Rajah Auto Supply Co.
Silvex Co., The
Splitdorf Electrical Co.

SPEED INDICATORS
FOXBORO CO., INC.
Johns-Manville, H. W., Co.
Stewart-Warner Speedometer Corp.

STABILIZERS
Greene Aeronautical Co.
Martin Aerodynamic Stabiliser.
SPERRY GYROSCOPE CO.

STAMPINGS
BLUM, JULIUS & CO.
Enameling & Stamping Corp. of New York
LANSING STAMPING & TOOL CO.
Dewes Co., The A.
STIMPSON, EDWIN B., CO.

STARTERS
Bijur Motor Lighting Co.
Bosch Magneto Co.
Christensen Engineering Co., The
Dayton Engineering Laboratories Co.
MOTOR-COMPRESSOR CO.
Northeast Electric Co.
Remy Electric Co.
Wagner-Hoyt Electric Co.

TANKS
Janney, Steinmetz & Co.

THERMOMETERS
FOXBORO CO., INC., THE
Moto-Meter Co.
TAYLOR INSTRUMENT COMPANIES.

TIRES AND RUBBER
DURAL RUBBER CORP.
GOODYEAR TIRE & RUBBER CO.
Hodgman Rubber Co.
United States Rubber Co.
WOOD, J. W., ELASTIC WEB CO.
Whitley Exerciser Co.

TOOLS
American Tool Works Co.
Bass Brothers
BLUM, JULIUS & CO.
Brooks Machine Co.
Browne & Sharpe
Buffum Tool Co.
Cooper Aeroplane Co., The John D.
HALL-SCOTT MOTOR CAR CO.
HAMMACHER, SCHLEMMER & CO.
LANSING STAMPING & TOOL CO.
Peck, Stowe & Wilcox Co.
Rich Tool Co.
Rogers Works, John M.
Smith & Hemenway
Whitman & Barnes Mfg. Co.

TRUCKS AND TRAILERS
Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Fruehauf Trailer Co.
Nash Motors Co.
Packard Motor Car Co.
Sechler Company, The
Service Motor Truck Co.
White Company, The

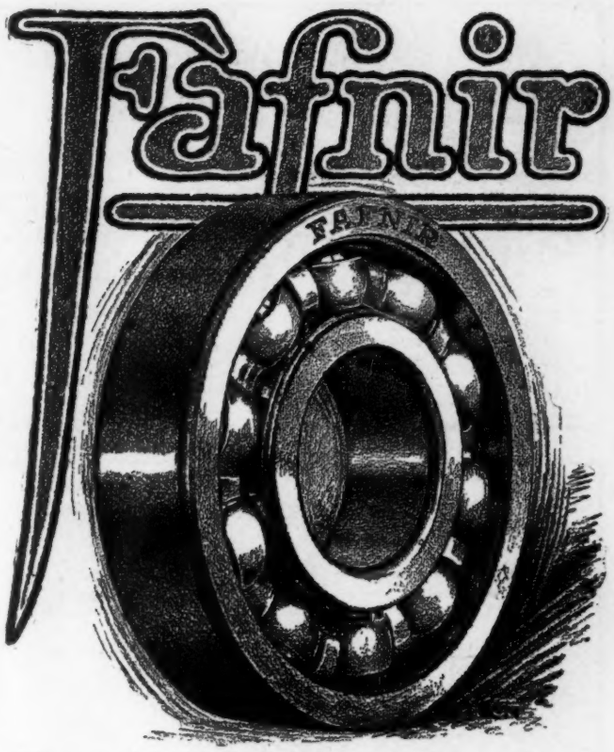
TUBING
American Tube Co.
BLUM, JULIUS & CO.
Dewes Co., The A.
Empire Art Metal Co.
Frasse & Co., Peter A.
National Tube Co.
Pennsylvania Flexible Metallic Tubing Co.
STIMPSON, EDWIN B., CO.

TURNBUCKLES
Aero Mfg. & Accessories Co.
Dayton Metal Products Co.
Dillner-Meyer Mfg. Co.
ERIE SPECIALTY CO.
National Aeroplane Co.
New York & Hagerstown Metal Stamping Co.
STANDARD TURNBUCKLE CO.
Steel Products Co.

WHEELS
ACKERMAN WHEEL CO.
Dayton Wire Wheel Co.
Hayes Wheel Co.
Mott Wheel Works
NATIONAL WIRE WHEEL WORKS.
Spranger Wire Wheel Corp.
Watson Wheel & Rim Corp.
Wire Wheel Corporation of America

WIRE
American Steel & Wire Co.
Century Telephone Construction Co.
Electric Cable Co.
NEW YORK WIRE AND SPRING CO.
Rathbone, A. B. & J.
ROEBLING'S SONS, JOHN A.
Simplex Wire & Cable Co.
Upson-Walton Co.

WIRELESS
American Radio & Research Corp.
American Wireless Telegraph Co.
Cutting & Washington, Inc.
Crocker-Wheeler Co.



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THE FAFNIR BEARING CO.

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Waterproof Ply Wood Panels of All Thicknesses and Plies

Stand Highest in Government Tests for Strength and Water Resisting Qualities

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ABSOLUTELY WATERPROOF AND ACCEPTED BY THE GOVERNMENT

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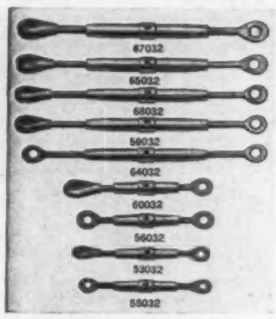

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REG. U. S. PAT. OFF.
The Premier Moulded Insulation

We maintain a research laboratory for the working out of new applications, including those pertaining to flying machines.

GENERAL BAKELITE COMPANY
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"Carry On"

The fighting slogan in France—on land, on sea, in the air, it rings sharp and clear. "Carry On" must be our slogan here at home until victory is won.

"Carry On"—Buy Liberty Bonds!

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The book every aviator will want to read, the authentic story of the greatest hero of the air

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By JACQUES MORTANE, translated by Clifton Harby Levy

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THIS COUNTRY SAID

"I'd like to buy more Liberty Bonds but—"

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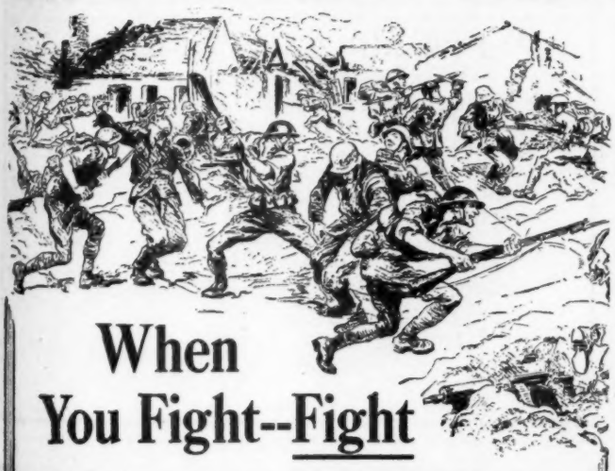

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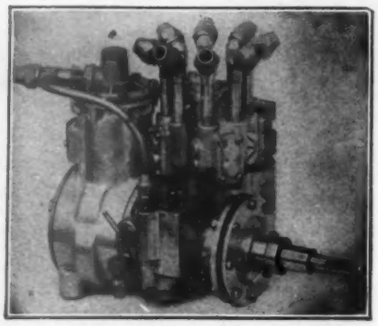

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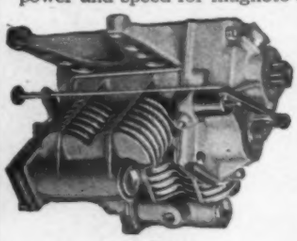

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INDEX TO ADVERTISERS

A

Ackerman Wheel Co. 378
Ajax Auto & Aero Sheet Metal Co. 384
Aluminum Brazing Solder Co. 390
Aluminum Castings Co. 342-343
Aluminum Co. of America 382
American Propeller & Manufacturing Co. 395
Automotive Engineering Co. 395

B

Baker Caster Oil Co. 346-386
Barcalo Mfg. Co. 385
Blum, Julius, & Co. 393
Boston Auto Gage Co. 388
Brock, Arthur, Jr. 393
Burgess Co., The 338

C

Certus Cold Glue Co. 382
Cold Light Manufacturing Co. 383
Curtiss Aeroplane & Motor Corp. 377

D

D. W. F. Engineering Co. 392
Dalton Manufacturing Corp. 376
Dayton-Wright Airplane Co. 340
Defiance Machine Works 376
Dixon, Joseph, Crucible Co. 388
Doehler Die Casting Co. 396
Duesenberg Motors Corp. 394
Dunwoody Institute 379
Dural Rubber Corp. 354

E

Eagle Aviation School 395
Ericsson Manufacturing Co. 387
Erie Specialty Co. 383

F

Fafnir Bearing Co. 391
Fahrig Metal Co. 390
Fedders Mfg. Co. 349
Ferdinand, L. W., & Co. 394
Flexo Manufacturing Co. 384
Foxboro, The, Co. 384
Fox Machine Co. 376

G

General Bakelite Co. 392
Goodyear Tire & Rubber Co. 341
Grand Rapids Veneer Works 380
Greb Company 353
G. and O. Mfg. Co. 386

H

Hall-Scott Motor Car Co. 335
Hammacher, Schlemmer & Co. 382
Hendee Manufacturing Co. 389
Hess-Bright Mfg. Co. 399

J

Jacuzzi Bros. 386

K

Kawneer Mfg. Co. 377

L

L. W. F. Engineering Co. 336
Lansing Stamping & Tool Co. 392

M

Martin, Glenn L., Co. 337
Mattison, C., Machine Works 376
Mayo Radiator Division 347
Motor-Compressor Co. 396

N

National Wire Wheel Works 394
New Departure Mfg. Co. 356
New York Wire & Spring Co. 392
Norma Co. of America 354

P

Palmer-Simpson Co. 395
Park Drop Forge Co. 381
Pratt & Lambert 398

R

Radium Dial Co. 350-381
Radium Luminous Material Corp. 396
Roebling's, John A., Sons Co. 395
Rome-Turney Radiator Co. 388
Rubay Co. 334

S

S. K. F. Ball Bearing Co. 400
Sherwin-Williams Co. 345
So-Luminum Mfg. & Eng. Co. 395
Sperry Gyroscope Co. 352
Standard Aircraft Corp. 378
Standard Turnbuckle Co. 390
Stimpson, Edwin B., Co. 393
Stone Propeller Co. 395
Strauss & Buegeleisen 380
Sturtevant, B. F., Co. 351

T

Taylor Instrument Companies 396
Terry, Herbert & Sons, Ltd. 383
Thomas-Morse Aircraft Corp. 348-379

U

Union Gas Engine Co. 344

V

Veeder Mfg. Co. 388

W

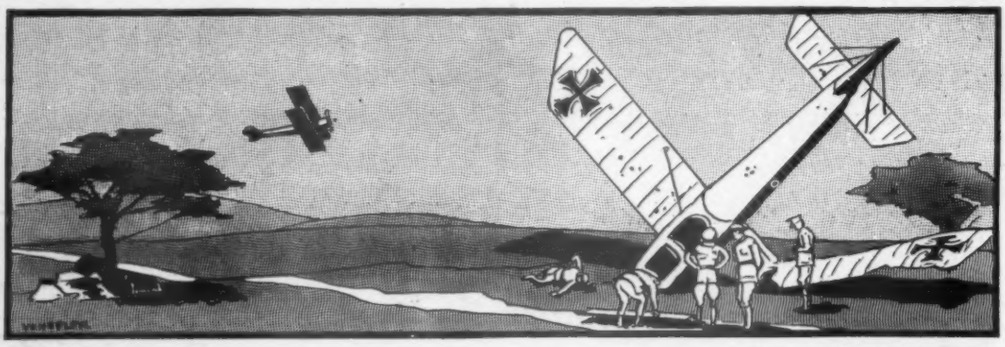
Wakefield, C. C. & Co., Ltd. 394
Warner, Wm. Deshler 395
West Woodworking Co. 389
Widman, J. C., & Co. 391
Wisconsin Motor Manufacturing Co. 394
Witteman-Lewis Aircraft Co. 379
Wood, J. W., Elastic Web Co. 390
Wright-Martin Aircraft Corp. 339
Wyman-Gordon Co. 355

Y

Yates, P. B., Machine Co. 384

Z

Zenith Carburetor Co. 392



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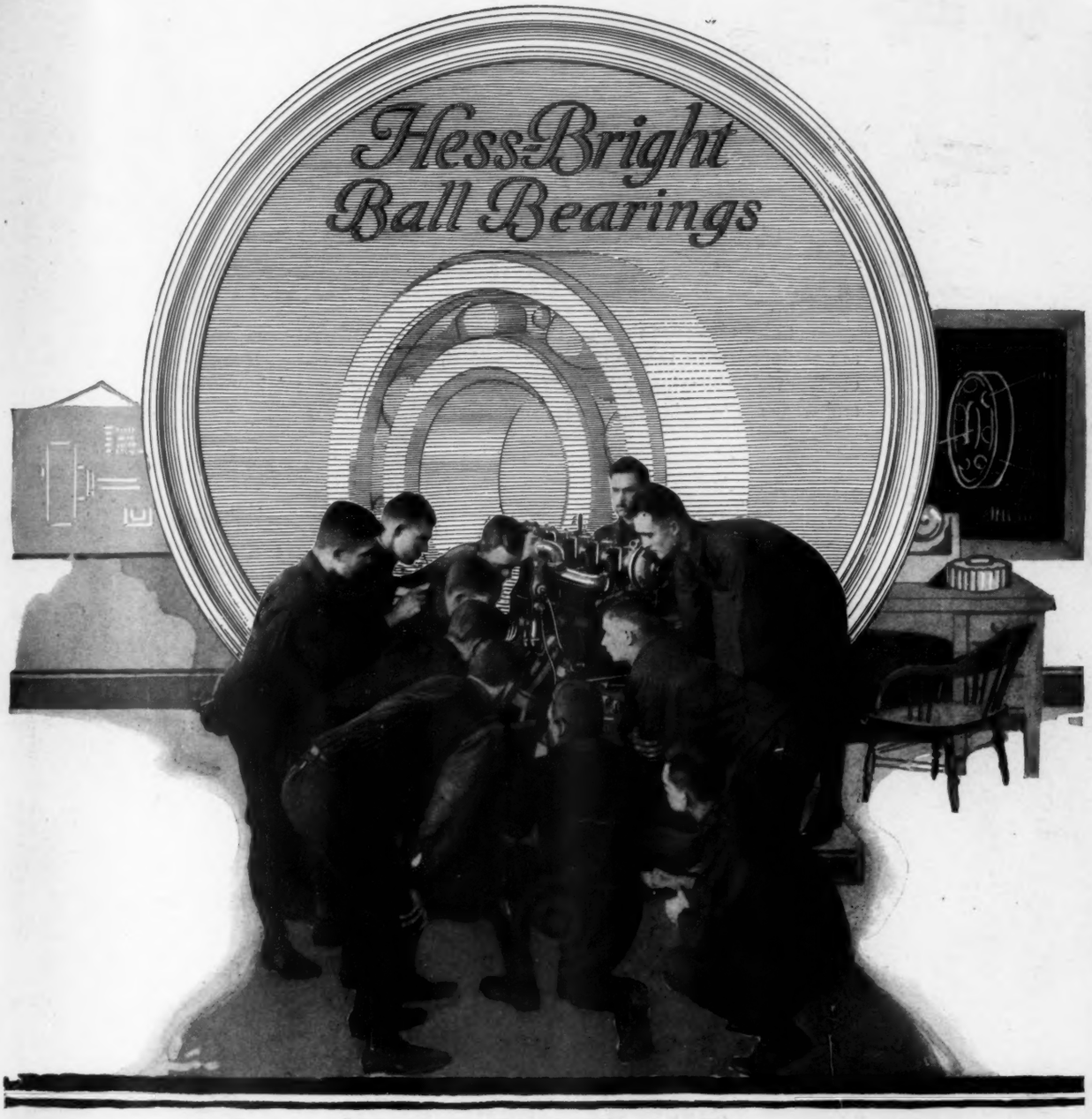

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